JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA.

FOR THE PROMOTION OF THE MECHANIC ARTS.

VOL. CXXXII. NOVEMBER, 1891. No. 5

THE Franklin Institute is not responsible for the statements and opinions advanced by contributors to the *Journal.*

BEVINGTON'S PROCESS OF WELDING METALS AND SPINNING AND SHAPING TUBES.

[*Report of the Committee on Science and the Arts.*]

[No. 1,647.] HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, September 3, 1891.

The Sub-Committee of the Committee on Science and the Arts, constituted by the Franklin Institute, of the State of Pennsylvania, to whom was referred, for examination,

JAMES H. BEVINGTON'S IMPROVED MODE OF WELDING METALS AND SPINNING AND SHAPING TUBES,

report, that this is the invention of which a very handsome display of products was exhibited at the stated meeting of the Institute, on the evening of June 17, 1891, and which was referred to the Committee on Science and the Arts by resolution of the Institute for examination, and if proper, for award.

The process herein described is owned and operated by

the New Process Welding and Spinning Company, 21 Rialto Building, Chicago, by whom it has been very intelligently developed.

The invention is the subject of United States Letters-Patent, No. 44,472, dated January 13, 1891, and of two subsequent applications for United States Letters-Patent, which have been examined and allowed, but are not yet published.

The invention consists in forcing strips, rods or tubes of ductile metal into converging revolving dies of harder metal, in which it becomes heated and compacted and acquires the shape of the interior of the die.

By employing a converging forming guide, the opposed surfaces of the ductile metal guide together like the binding guide of a sewing machine, and a tube may be made from a strip of ductile metal which, passing through a hollow non-rotating sliding arbor in which it is clamped firmly, it is forced into a funnel-shaped steel die, and becomes welded so soundly, that the seam is of equal strength with the rest of the metal, and in fact, cannot easily be detected without inspecting the interior surface.

Instead of supplying the strip of metal endwise, with edge parallel with the axis of the tube, the strip may be introduced obliquely, and wound helically on the tube, the welding operation being conducted in the same manner in the converging die, seamless tube being the result.

Separate wires, with the ends scarfed, placed in a similar die and similarly located, become firmly welded. No fluxes are either used or required. Tubes are reduced in diameter and extended in length by this process, and, what appears remarkable, although no core is used to sustain the metal internally, the thickness of the metal of the tube, when reduced in diameter, remains, without any material variation, the same, and the degree of temper, or hardness and elasticity of the metal do not appear to be impaired by this process.

The apparatus is shown in the accompanying engravings reproduced from the drawing of the inventor's specification.

The first illustration shows the application of the invention to contracting, and closing and welding the ends of

tubes. *Fig. 1* represents a sectional elevation of a lathe for spinning tubes or other straight articles according to this method. *Fig. 2* represents a horizontal longitudinal section of the same in the plane of its axis showing the die or former used in the process of reducing a metal tube to one of

FIG. 3.

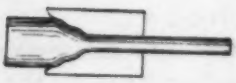


FIG. 5.

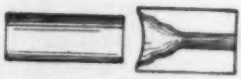


FIG. 4.

FIG. 14.

FIG. 13.

FIG. 12.

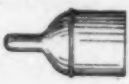


FIG. 11.

FIG. 10.

FIG. 9.

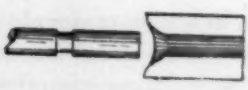


FIG. 8.

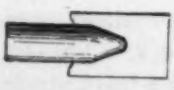


FIG. 7.

FIG. 6.

smaller diameter. It also shows the tube before being operated upon. *Fig. 3* is an end elevation of the die or former. *Fig. 4* shows a lengthwise section of the die and also a tube before reduction. *Fig. 5* shows the tube and die after the tube has been operated upon. *Fig. 6* is a longi-

tudinal section of a die where it is desired to close the end of the tube. The tube is also shown. *Fig. 7* is a view showing the operation completed. *Fig. 8* represents the die used to weld two tubes together for the purpose of lengthening the same.

Figs. 9, 10, 11, 12, 13 and *14* represent some of the different results accomplished by the process of reducing and increasing the diameter and closing the ends of the metal tubes. *Fig. 15* shows a detached view of a tube as partially formed from a strip of metal. *Fig. 16* shows the invention as applied to welding the ends of wires or rods.

The machine adapted to carry out this process is substantially a lathe, with hollow arbors in both the head and tail stocks. A conical die is secured upon the inner end of the hollow arbor of the head stock so as to turn with it. This die is of very hard metal, and has a central perforation running through it, conical or flaring at each end, the opening at the inner end being much larger than the one at the other end.

The hollow spindle of the tail stock is screw-threaded and is mounted in a threaded bearing so that it can be set in and out, for which purpose it is provided with a hand wheel. A contractible clamp is set in the inner end of this arbor, which is adapted to hold the rod or wire from turning as well as lengthwise.

The engravings show this machine in operation upon wires. The two wires are preferably prepared by scarfing or by cutting the ends upon an incline, as shown in *Fig. 17*, so as to give each a corresponding bevel. One of the wires is thrust through the hollow shaft and part way through the die, and the wire is fastened in this position by means of the clamp at the rear of the head stock. The other wire is inserted in the tubular spindle of the head stock and passed out through the clamp a little way, and is then firmly secured in place by means of this clamp.

The arbor of the tail stock is then fed inward until the bevelled end of the wire is forced into the die and brought firmly against the bevel of the other wire. The die is then very rapidly revolved by the means already explained,

while, of course, the two wires are held in a fixed position and forced together. During this rapid movement of the die, a very high degree of heat is developed by frictional contact, which is of sufficient intensity to heat the two ends of the wire to a welding heat and perfectly weld them together along their contact faces. The union thus obtained is as complete and perfect as a welded joint can well be made, and, owing to the action of the die, the joint is smooth and in fact almost imperceptible, the finished wire presenting the appearance of a smooth cylinder seen in *Fig. 18*.

Obviously, with the machine constructed as described above, the wire, after being welded, must be drawn through at one end of the machine. For this purpose the wires are wound upon spools at each end of the machine. After welding, the wire may be drawn through, being run off from one spool and wound upon the other, the clamps, of course, being loosened for this purpose, and so length after length of wire may be joined together to form a line of any length desired.

Two rods may be welded together in the same way, one being set in the head stock and the other in the tail stock, and both clamped as described.

The operation will be understood without any further explanations, the rod set in the tail stock being fed up forcibly against the end of the opposite rod.

This process of welding may be successfully applied to wires and rods of very considerable size; the process has been practically tested with entirely satisfactory results on rods of different sizes, up to one inch in diameter, and probably may be carried on successfully with even larger sizes.

The invention is applied to forming tubes of metal, as shown in *Figs. 1* and *2*.

The machine used is a lathe, as previously described, with some additional features. The tail stock is hollow and suitably threaded to serve as a feeding device, for which purpose it is provided with a hand wheel on its outer end. A clamp is set in the inner end of the arbor of the tail stock,

being of any suitable construction to clasp and firmly hold a round tube. It is shown in *Fig. 19*, in the well-known form of a divided ring with a screw for the purpose of drawing the two parts together. A standard is mounted upon the bed beyond the tail stock, and on this standard is mounted a mandrel which corresponds in size to that of the required tube.

This mandrel extends just through the standard, which is provided with an aperture for this purpose, a little larger than the mandrel, its diameter corresponding to the outer diameter of the tube. At its outer end, the mandrel is bent upward and backward upon itself, and this upper turn or member is fastened to the top of the standard by means of a screw body as seen in *Fig. 1*, or in any other suitable way. The metal plate from which it is intended to form the tube, is cut into a strip or strips of such width as to form a tube of the desired size, when rolled up in a circular form with the opposite edges brought together; this strip or strips may be wound upon a suitable drum a little in front of the mandrel standard, where the strip is shown wound or coiled upon the drum, the latter being free to turn its axis so that the strip may be run off.

The operation is as follows: the metal strip wound upon the drum as described, is led thence through the aperture in the standard, bent around the mandrel, by which operation it is formed up around the mandrel in the shape of a tube, the edges of the plate being brought close together, but of course not joined.

The end of this unclosed tube is carried along the tail stock; and in the revolving die, the clamp is then closed tightly upon the tube, and the revolving die set in motion. The tail stock, which, in the first instance, is drawn back as far as possible, is now set up gradually, thus feeding the unclosed tube into and through the revolving die, and by the action of the hard-faced conical die, rapidly revolving, the tube is heated to a welding heat, and the edges thoroughly and completely welded together, thus closing the joint and leaving a perfectly smooth and finished surface.

The feeding of the tube through the die will, of course,

draw the strip from the drum and through the forming aperture in the standard, thus continuously forming up the tube around the mandrel during the feeding operation. With the device here shown, it is obvious that when the limit of the feed movement of the tail stock is reached, the clamp must be loosened; the tail is again retracted, the clamp refastened, and the feed forward is again made. The tube, delivered from the hollow shaft will be a completed product, with the joint perfectly closed and smoothly finished by the action of the die, so as to present a seamless appearance. It is evident that the metal from the drum to the hollow shaft will present three different conditions; the first section between the roll and forming mandrel, is straight, but with its edges gradually turning upward and inward, as seen in *Fig. 2*, and the second section, between the mandrel and the revolving die, will be in the form of an enclosed tube, as indicated in *Figs. 2* and *15*, while the last section, beyond the revolving die, will be a finished tube.

It will be seen that in carrying out the process with the apparatus herein shown and described, the feed is intermittent, but that a tube can be made of any length desired. It is also evident that if a feed mechanism were applied to the tube by which the metal would be drawn through the machine by a slow continuous movement, the action of the devices would be constant, there being no intermission in the feed. Sections of welded specimens show the weld to be perfectly solid and fully equal in strength to the rest of the material.

The capacity of this invention for uses in the arts seems to your committee as almost unlimited, when circular forms of ductile metal are required. The series of helically coiled or twisted wires welded as shown in *Fig. 20* is one of the many interesting specimens produced by this invention.

It has already been applied commercially, with satisfactory results, to cartridge cans for dynamite projectiles, and, so far as your committee can judge, develops fully the best strength of the material.

The invention appears entirely novel, is simple and

easily managed and economical, and does not require a very costly plant, and in the opinion of your sub-committee deserves recognition by the award of the Elliott Cresson Medal.

LUTHER L. CHENEY, JOHN HALL,
FRANCIS LECLERE.

Adopted, September 2, 1891.

S. LLOYD WIEGAND,
Chairman of the Committee on Science and the Arts.

GOETZ-MITCHELL SYSTEM OF ANCHORING BEAMS IN BUILDING CONSTRUCTIONS.

[*Report of the Committee on Science and the Arts.*]

[No. 1,639.] HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, September 3, 1891.

The Sub-Committee of the Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, to whom was referred for examination,

THE GOETZ-MITCHELL SYSTEM OF ANCHORING BEAMS IN BUILDING CONSTRUCTIONS,

report, that this invention is the subject of, and is fully described in, letters-patent of the United States granted to Mansell Mitchell and Henry A. Goetz, numbered and dated, respectively, 386,976, dated July 31, 1888; 387,004, dated

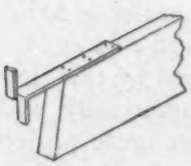


FIG. 1.

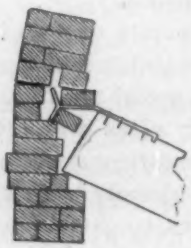


FIG. 2.

July 31, 1888, and 437,592, dated September 30, 1890; these are appended and form part of this report.

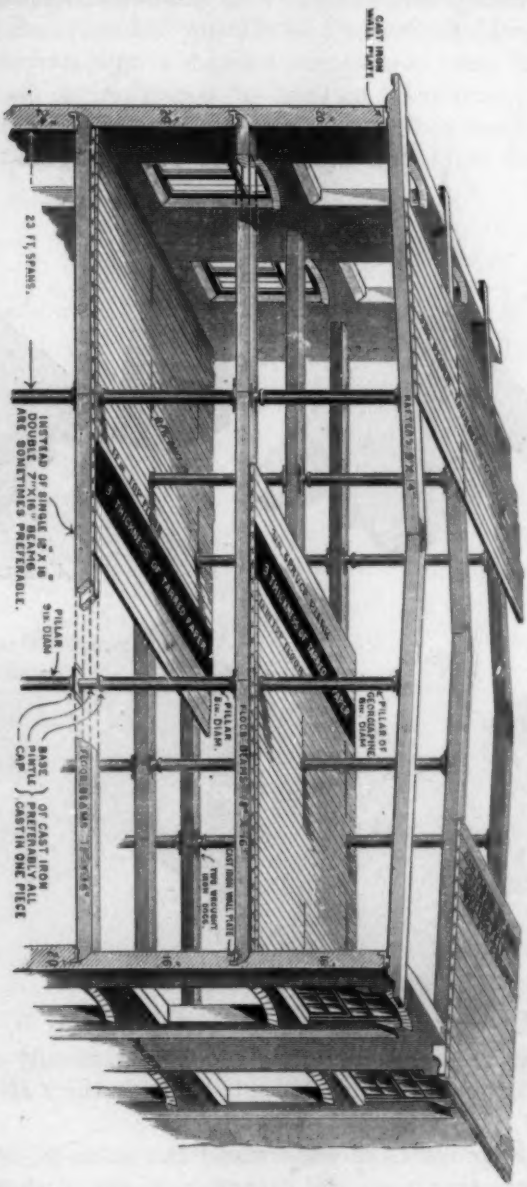

CAST IRON WALL PLATE
23 FT. SPANS.
INSTEAD OF SINGLE 12" I BEAMS DOUBLE 7"x15" I BEAMS ARE SOMETIMES PREFERABLE.
PILLAR 9in. DIAM.
3 THICKNESS OF TAPERED PLATES
PILLAR 8in. DIAM.
PILLAR OF GEOGRAPHIC 8in. DIAM.
CAST IRON WALL PLATE
TYPE WEIGHT IRON BOXES
BASE PINTLE CAP
OF CAST IRON PREFERABLY ALL CAST IN ONE PIECE

FIG. 3.

This invention does away with the objectionable features of the usual method of anchoring beams, and is, in the opinion of your committee, a decided improvement on the present "standard" method of constructing floor beams, with cast-iron wall plates and base, pintles and caps (cast in one piece) employed first by the New England Factory

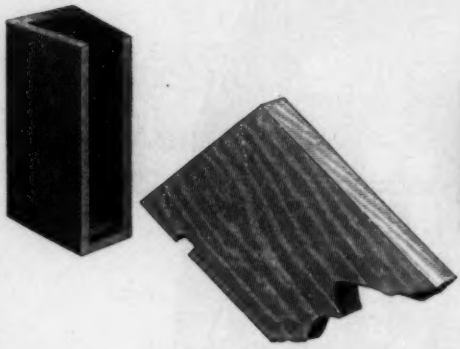


FIG. 4.

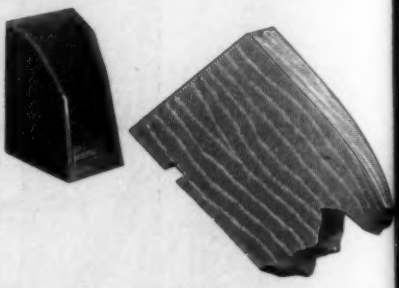


FIG. 5.

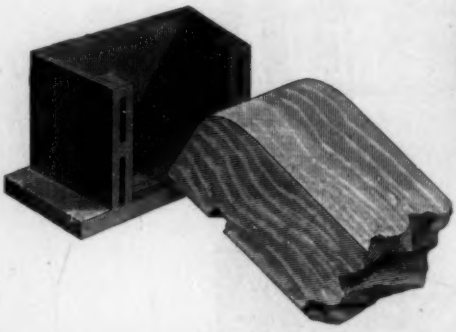


FIG. 6.

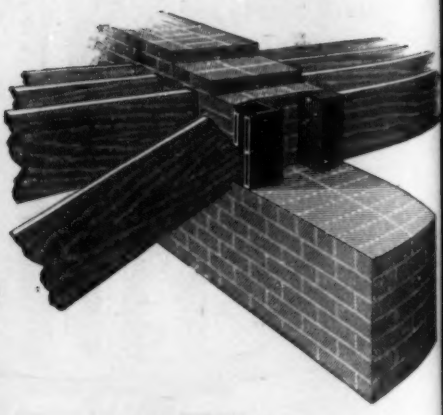


FIG. 7.

Mutual Insurance Companies, and now generally employed in manufacturing establishments built on the "*slow-burning principle.*"

In order properly to understand the value of this invention, your committee calls attention to *Fig.* 1, showing one of the old methods of anchoring beams; *Fig.* 2, showing

the effect where a beam so anchored burns through. (Taken from the *Indicator*, Detroit, Mich., December, 1889.)

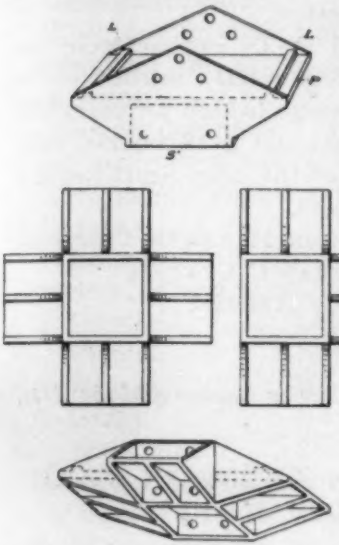


FIG. 8.

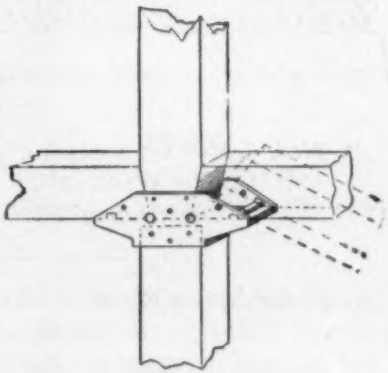


FIG. 10.

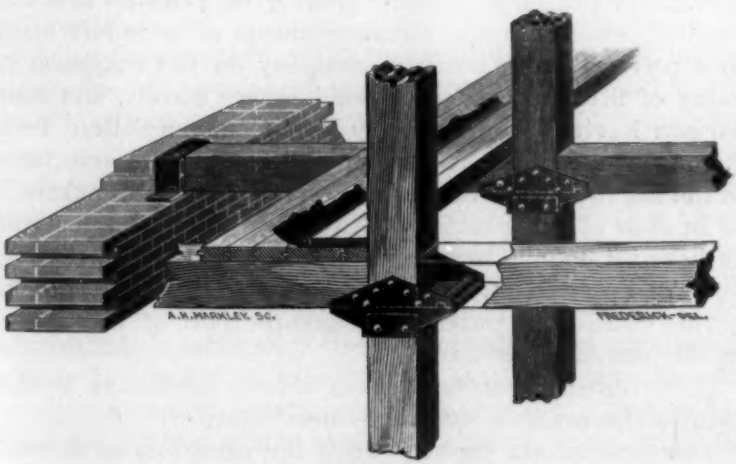


FIG. 9.

Fig. 3 shows a standard "slow-burning" building construction.—(Taken from John R. Freeman's paper, presented September 17, 1890, "Comparison of English and [Ameri-

can Types of Factory Construction," in the *Journal of the Association of Engineering Societies*); and lastly, *Figs. 4* to *10*, which show the Goetz-Mitchell Method.

In view of the fact that this is an improvement on former methods, and will tend, if generally introduced, to lessen our enormous annual fire waste (which for years has annually been between $100,000,000 and $128,000,000) your committee recommend the award of the John Scott Legacy Medal and Premium to the inventors.

C. JOHN HEXAMER, *Chairman*,
THOMAS P. CONARD,
STACY REEVES.

Adopted, September 2, 1891.

S. LLOYD WIEGAND,
Chairman of the Committee on Science and the Arts.

A COMPARISON OF FIFTEEN AMERICAN VARIETIES OF SOLID EMERY WHEELS.

Among the matter for publication submitted to the Committee in charge of the *Journal of the Franklin Institute*, October 7th, were the advance sheets of a report made to a private manufacturing company on the comparative value of fifteen varieties of solid emery wheels, the comparison having been made by Prof. Coleman Sellers, Prof. J. E. Denton and Mr. Alfred R. Wolff, who were associated in the inquiry at the instance of one of the wheel makers.

In view of the paucity of literature on this subject and as bearing upon a lecture delivered December 9, 1889, by Mr. T. Dunkin Paret, before the Franklin Institute, the committee decided to publish the greater part of this report in the words of its authors.

After stating how the authors became associated in this inquiry the report continues as here follows:

Our first object was to settle the question as to what constitutes a good solid emery wheel.

Our second object was to establish test conditions of such scientific accuracy as to prevent any doubt of the results.

Our third object was to give thorough trial, under uniform test conditions, to the various wheels, and to secure a mass of exact data.

The investigation thus outlined has been of the most painstaking and thorough character, and has lasted about two years.

Having determined on the qualities which constitute a good solid emery wheel, we established our own conditions of test, and submitted to such conditions wheels of our own selection.

The wheels of fifteen different manufacturers were selected. These were:

Celluloid,	Lehigh,	Tanite,
Crystal,	Norton,	Union stone,
Detroit,	Northampton,	Vitrified,
Grant,	Norwich,	Vulcanite,
Hampden,	Sterling,	Waltham.

Among these fifteen varieties only one compared favorably with the Tanite wheel, the latter having easily beaten all competitors save one. The comparative values of the Tanite and its single rival will have to be ascertained by further trials.

After careful study of the literature relating to grinding processes, we witnessed actual grinding by solid emery wheels in various factories; then, in company, twice visited the works of the Tanite Company, and observed a series of trials with Tanite and other wheels, in which the metal was in some cases applied by hand pressure, and in other cases, without such pressure upon machines built expressly for testing purposes. It was unanimously agreed that hand-testing must be done away with and the personal factor eliminated, in order that the results might be unimpeachable. The defect of existing test machines was speedily recognized, and it became necessary to invent a new testing machine. After much study and many trials, with the valuable assistance of Prof. J. Burkitt Webb, we constructed a machine which met the approval of all concerned.

This machine was so constructed that the wheel and work were brought in contact by definite and measurable

pressure without any obstacle being interposed to the free wear of either metal or wheel. The results approximated closely to those obtained by hand-pressure, and yet were independent of all influence from the operators of the machine. The power consumed was measured by a dynamometer attached to the driving shaft and the speed recorded by a tachometer. The resistance between wheel and metal was indicated continually by a standard scale.

After many preliminary trials with this machine its results were compared with those obtained by individual operators under various conditions, and experiments with skilled workmen, expert grinders, were made.

It was agreed, that to constitute a good solid emery wheel, the following qualities should be combined; safety under the widest conditions of use and misuse; rapidity of cut; freedom of cut at moderate pressure; reasonable amounts of wheel loss and power consumption; evenness of wear; general staying quality; and reliability under the widest range of circumstances.

We then agreed upon a programme of work—had the test machine erected in the machine shop of the Stevens Institute of Technology at Hoboken—and had the various wheels (bought directly by themselves in the the open market) delivered there. The grinding was done on cast-iron bars supplied directly to us by one founder, special care being taken as to quality of metal and size of bar. The trials reported on were made at the Stevens Institute during 1889 and 1890, the tabulations being too voluminous to admit of detail here.

In preliminary and collateral investigation many trials were made with hand pressure, and some under measured pressures of ten pounds and seventy-five pounds; but our report is based on a long series of trials at three different pressures—forty-two pounds, sixty pounds and 100 pounds. These separate trials numbered several thousand, during each of which exact data were recorded as to speed, power, resistance between wheel and metal, amount of metal ground off, amount of wheel material consumed, and observations made as to the cleanness of cut, amount of heat

generated, amount of glazing or clogging up of wheel with metal, and as to cracks, breaks and defects of wheels.

Of the fifteen varieties six were found too unsafe to warrant their general use, fifty-seven per cent. of the wheels bursting under the same conditions which other wheels passed through uninjured. Eleven varieties (among which are included the six unsafe varieties) were found to be such slow cutters that the average metal removal of ten of them was less than the general average of all the wheels. Of the fifteen varieties only four were found to be rapid cutters. Of these one wore so rapidly that the cost of its rapid cut was unreasonable. This left three, safe, effective and satisfactory wheels, one of which, however, was demonstrated to work at a greater cost than the Tanite. The rivalry was thus narrowed to two wheels, and, in the judgment of our board, further trials are necessary before the relative value of these two can be determined.

One striking feature characterized these two. That is, that in every series of trials these wheels increased in productive capacity, the average of the last cuts of all the series being greater than the average of all the first cuts. The thirteen other varieties all decreased in productive capacity, the average of the last cuts being less than the average of the first. Some of these which made a brilliant show at the start, cut scarcely anything at the close.

Our investigation satisfied us that the ordinary user of solid emery wheels is likely to be deceived as to the productive capacity of such wheels and the cost of product if he trusts to mere appearances, and that the real value of any solid wheel can only be fixed by an investigation which gives exact data and covers a wide range of observation.

Such an investigation ours has been, each fact being observed and attested by several independent witnesses trained to scientific observation, and each calculation and measurement being passed through and checked by several hands.

This investigation demonstrates the unquestionable superiority of the Tanite wheel to thirteen out of fourteen competitors.

As nearly all the preliminary and collateral trials were made with Tanite wheels more than three times as many of these were used as of any other make. In all this use, under every degree of measured automatic pressure and under the heavy pressure of long bars used by hand (a test applied to no other wheel) and also at a speed nearly double that of any other wheel save one, *no Tanite wheel burst or broke*. The safety of the Tanite wheel can be considered unquestionable. The cutting power of the Tanite wheel did not deteriorate with use, its average last cuts always exceeding its average first cuts. The Tanite wheel cut well at moderate pressure.

The consumption of power and of wheel material is such that, taking into account the cost of labor and all other items entering the problem, the Tanite wheel does its work at a very low cost.

In the use of all tools and machines, consideration should be given to their regularity and uniformity of action and to their freedom from such stoppages as arise from a variety of undefined and unforeseen causes. From a great variety of causes many of the competing wheels failed to complete their series of trials, and gave rise to frequent incidental stoppages. Such was not the case with the Tanite.

As evidence of these facts, thus summarized and stated in a general manner, we possess an overwhelming mass of exact data in the form of numerical tabulations. These details are reserved for future publication.

COLEMAN SELLERS,
J. E. DENTON,
ALFRED A. WOLFF.

THE DEVELOPMENT OF THE PIG IRON MANUFACTURE IN THE UNITED STATES.*

By JOHN BIRKINBINE,
President, American Institute of Mining Engineers.

Few articles which we manufacture have been so liberally discussed by political economists as pig iron, and in legislation concerning our customs duties, this product has assumed such a prominent position that we may infer that this particular industry is recognized as exerting a marked influence upon the progress of the country at large, and especially upon certain sections thereof. Facts sustain this inference and probably no one industrial pursuit, except possibly coal mining, has done more to advance the United States than the manufacture of pig iron and by this manufacture much assistance has been given to the great development of the coal mining industry, a development which now contributes about 150,000,000 tons annually, or thirty per cent. of the world's output of coal.

To trace the practical growth of pig iron production we need not go back 270 years to the first unsuccessful attempt at iron manufacture in Virginia, nor discuss the pioneer iron works erected at Lynn, Mass., in 1643, to treat the bog ores occurring near the coast, nor those following in Connecticut, Rhode Island, and New Jersey, nor need we recite the history of the older plants in New York, Pennsylvania, Virginia and Maryland, whose business records are associated with the history of the nation's struggle for independence. In this connection, attention may well be invited to the fact that much of the earlier advancement in iron production and manufacture was based upon the use of bog ores, which abound along the Atlantic seaboard but which are now lightly esteemed

* A lecture delivered before the Franklin Institute.

and employed to a limited extent only, on account of their lean character and scattered deposits.

A majority of the men now living have seen the years which mark the commercial development of this industry, and the last two decades and a half are the most pronounced in remarkable results. Beyond, therefore, a mere statement indicating the earlier growth of the pig-iron industry and a few remarks upon it, no effort will be made to discuss the subject of development for a period beyond twenty-five years.

This lecture will briefly summarize the progress made in the past twenty-five years in pig iron production in the United States, with reasons therefor, and give contemporaneous data as far as obtainable from other nations which make large outputs of this metal.

It will note the distribution of this industry in different sections of this country, and the relative advance made by each, and also call attention to the prominent position which Pennsylvania has occupied, and the preëminence the State has now attained.

It will also indicate the probable future growth of pig iron production, and discuss, in a general way, the prognostications as to a future situs of pig iron productions.

No attempt will be made to trace the industry beyond the primary process of producing pig iron, nor will any reference be made to the obvious influence which governmental protection has upon its development.

GROWTH OF THE INDUSTRY.

Mr. James M. Swank, in his reports to the American Iron and Steel Association, states that the total output of pig iron in 1810 was 54,000 gross tons, increasing threefold to 1830, when it was 165,000 gross tons, and this again twofold to 1840, when it reached 286,903 gross tons; the output for 1850 being 563,755 gross tons, and for 1860, 821,223 gross tons.

These figures show that, while the production of 1860 was less than one-eleventh that of last year (1890, when 9,202,703 tons were made), it was five times greater than in

1830. Taking the record for the past half century, the above data indicates that the *pig iron output of 1890 was over thirty times that of 1840.*

Until 1840, all of this iron was made with charcoal and by far the greater portion of it was still produced with that fuel in 1850. The year 1855 was the first recorded in which the production of pig iron by the use of anthracite coal exceeded that made with charcoal, and in that same year, the amount of pig iron made with bituminous fuel was but eight per cent. of the total output. However, from 1855, anthracite kept in advance of the use of charcoal, and in 1860, the relative proportions of iron made with the different fuels were practically twice as much charcoal pig iron as coke iron, and twice as much anthracite iron as charcoal iron.

It was in 1864, that the United States first made 1,000,000 gross tons of pig iron, falling below that figure in 1865, but exceeding it in 1866. It would, therefore, be unfair to use the comparatively small output for 1865 as a gauge for subsequent growth therefor, and the production for twenty-five years, beginning with 1866, will be taken. We find from Table A, that the pig-iron industry advanced so rapidly that in six years, namely, 1872, more than double the amount of pig iron was produced than was made in 1866; in fourteen years (1880), the output was over treble that of 1866; in sixteen years (1882) it was almost four times the output of 1866; in twenty-one years (1887) it was over five times the output of 1866; in 1889, twenty-three years after, it was over six times the output of 1866, and in 1890, it was seven and five-eighths times the production of 1866.

This is truly a remarkable record of progress, and one which has never been duplicated in this or in any other country in a similar interval of time, and it may never be again, for if our output of pig iron increased seven and five-eighths times that of 1890 in the next twenty-four years, it would exceed 70,000,000 gross tons per annum, and equal in one year the aggregate production of pig iron for the past sixteen years.

TABLE A.

Annual Production of Pig Iron in the United States from 1866 to 1890.

	Recorded Number of Blast Furnaces.	*Number of Blast Furnaces Operating at Close of Year.*	*Production. Gross Tons of 2,240 Pounds*
1866,	—	—	***1,205,663***
1867,	—	—	1,305,023
1868,	—	—	1,431,250
1869,	—	—	1,711,287
1870,	—	—	1,665,179
1871,	—	—	1,706,793
1872,	612	—	2,548,713
1873,	657	410	2,560,963
1874,	693	365	2,401,262
1875,	713	293	2,023,733
1876,	712	***236***	1,868,961
1877,	**716**	270	2,066,594
1878,	692	265	2,301,215
1879,	697	388	2,741,853
1880,	701	446	3,835,191
1881,	**716**	**455**	4,144,254
1882,	687	417	4,623,323
1883,	683	307	4,595,510
1884,	669	***236***	4,097,868
1885,	591	276	4,044,526
1886,	577	331	5,683,329
1887,	583	339	6,417,148
1888,	589	332	6,489,738
1889,	570	344	7,603,642
1890,	***562***	311	**9,202,703**
A total output for twenty-five years of,			88,275,721

of which 56,902,041 tons were produced in the decade just closed. The maxima are in full-faced figures, the minima are in italics.

The pig iron produced in twenty-five years, if run in a solid mass, would cover one square mile, to a depth of sixteen feet.

DISTRIBUTION OF THE PRODUCT.

The statistics, collected from the manufacturers and published by the American Iron and Steel Association, show a total production of pig iron for the year 1890 of 10,307,028 net tons, or 9,202,703 gross tons, made in about 340 furnaces,

which were in operation for some portion of the year, although but 311 were active at the close of that year.

Of the total output:

6,388,147 gross tons, or about seventy per cent., was made by using bituminous coal.

2,186,411 gross tons, or twenty-four per cent., was made by using anthracite fuel in whole or in part, but only 249,271 gross tons, or two per cent. of the total output, was smelted with anthracite coal alone.

628,145 gross tons, or six per cent., were made with charcoal as fuel. This is the largest amount of pig iron made by the United States in any one year by the use of this fuel, indicating improvement in this specialty, although the relative proportions of charcoal pig iron to the total is yearly diminishing.

Of the total production, 4,092,343 gross tons, or about forty-four per cent., were classed as Bessemer pig iron for the production of steel by the acid process.

The quantity of domestic spiegeleisen and ferro-manganese produced was 133,180 gross tons, or about one and a half per cent. of the total pig iron made in 1890. Practically all of this was used in steel manufacture.

At the close of 1890, the stocks of pig iron in makers' hands was 661,858 gross tons, or about seven per cent. of the total output.

Pennsylvania is credited with making 4,415,329 gross tons of pig iron, or nearly forty-eight per cent. of the total output for 1890, which still maintains this State in advance of all others.

Ohio ranks second with 1,240,330 gross tons, or thirteen per cent. of the total.

Alabama advanced last year to third in order of production, with an output of 816,911 gross tons, or nearly nine per cent. of the total, and

Illinois is fourth in importance, with a production of 701,106 gross tons, or seven and a half per cent. of the total.

Pennsylvania and Ohio together produced 5,655,659 gross tons, over sixty-one per cent. of the total output, and the aggregate of the four States, Pennsylvania, Ohio, Alabama

and Illinois, was 7,173,676, or nearly seventy-eight per cent. of the country's production of 1890.

COMPARISON WITH OTHER COUNTRIES.

The year 1890 is memorable as placing the United States in the lead, our output of pig iron being larger than that of any other nation, and our development may be emphasized by a comparative statement of the product by various countries within late years. (See Table B.)

An examination of the published tables of production of pig iron in this and other countries gives a close approximation, although not an absolute determination of the figures for the reason that it is not always possible to obtain contemporaneous data for the different countries. However, taking the most reliable records, we find that Great Britain first made 1,000,000 gross tons of pig iron per annum, in 1835, but the United States did not reach that figure until twenty-nine years later, namely, 1864, in which year Great Britain produced 4,750,000 tons. In 1866, the commencement of the period under discussion, the United States produced one-quarter of the annual output of Great Britain, and approximated the output of Germany and France. For four years following the United States, Germany and France kept well together in output. Great Britain produced 2,000,000 tons of pig iron in 1847, twelve years after it had made 1,000,000 tons; but the United States reached this figure in 1872, eight years after it had made 1,000,000 tons. It was then twenty-five years behind Great Britain. Germany made 2,000,000 tons in 1873, and France did not reach the production of 2,000,000 tons until 1882.

After an interval of seven years from the date that Great Britain reached 2,000,000 tons of pig iron per annum, namely, 1854, that nation made 3,000,000 tons, and the United States did not cover the same ground until an interval of eight years, namely, 1880, while it took Germany nine years, namely, to 1882, to make this product. France has never yet reached an annual product of 3,000,000 tons. After another interval of nine years, viz: 1854 to 1863,

Great Britain added another million to its output, making the production 4,000,000, but the United States covered this ground in one year, being at that time eighteen years behind Great Britain, and it took Germany five years to increase its output from 3,000,000 to 4,000,000 tons, reaching the latter figure in 1887. An interval of five years sufficed for Great Britain to reach a production of 5,000,000 tons, in 1868, and a similar interval brought the United States to the same output in 1886. Germany has never reached 5,000,000 tons. To pass the figure of 6,000,000 tons annual production, Great Britain required three years more, while the United States reached the same figure in one year, making the latter country sixteen years behind the former. In nine years for Great Britain and two years for the United States, each of these countries passed the production of 7,000,000 gross tons viz: in 1880 and 1889, respectively.

Great Britain's largest pig iron output was in 1882, when 8,586,680 gross tons were produced; the United States' maximum annual output was in 1890, viz: 9,202,703 gross tons. Germany's greatest output was in 1890, when 4,563,025 metric tons were produced, and the largest output for France was 2,067,387 metric tons in 1883.

Of the other pig iron producing countries Austro-Hungary, Sweden, Belgium, Italy, Spain, Canada and Russia, none have produced in any one year 1,000,000 gross tons. The largest reported output from Austro-Hungary was in 1889, when 816,156 metric tons were produced; that of Sweden was in 1885, viz: 464,737 metric tons; the maximum output for Belgium was in 1889, when 832,226 metric tons were made, and in Russia the data have been so irregularly published as to make the figures uncertain, the report of 1888 of 612,000 metric tons being the largest published output. Spain produced 232,000 tons in 1888; Italy produced 12,265 tons in 1887, and Canada produced 18,191 tons in 1888.

The official statistical data for Great Britain covering the year 1890 show that 7,904,214 gross tons of pig iron were made. The United States therefore produced over sixteen per cent. more pig iron in 1890 than Great Britain.

TABLE B.

Annual Production of Pig Iron in Various Countries from 1866 to 1890 Inclusive.

	Gross Tons of 2,240 lbs.		Metric Tons of 2,204 lbs.	
Years.	*United States.*	*Great Britain.*	*Germany.*	*France.*
1866, ...	1,205,663	4,523,897	—	1,260,348
1867, ...	1,305,023	4,761,023	1,113,606	1,229,044
1868, ...	1,431,250	4,972,206	1,264,347	1,235,308
1869, ...	1,711,287	5,445,757	1,413,029	1,380,965
1870, ...	1,665,179	5,963,515	1,391,124	1,178,114
1871, ...	1,706,793	6,627,179	1,563,682	859,641
1872, ...	2,548,713	6,741,929	1,988,394	1,217,838
1873, ...	2,560,963	6,566,451	2,240,574	1,366,971
1874, ...	2,401,262	5,991,408	1,906,262	1,423,308
1875, ...	2,023,733	6,365,462	2,029,389	1,416,228
1876, ...	1,868,961	6,555,997	1,846,345	1,453,112
1877, ...	2,066,594	6,608,654	1,932,725	1,400,000
1878, ...	2,301,215	6,381,051	2,147,641	1,417,072
1879, ...	2,741,853	5,995,337	2,226,587	1,334,759
1880, ...	3,835,191	7,749,233	2,729,037	1,725,293
1881, ...	4,144,254	8,377,364	2,914,009	1,899,861
1882, ...	4,623,323	8,586,680	3,380,806	2,039,067
1883, ...	4,595,510	8,529,300	3,469,719	2,067,387
1884, ...	4,097,868	7,811,727	3,600,612	1,855,247
1885, ...	4,044,526	7,415,469	3,687,433	1,630,648
1886, ...	5,683,329	7,009,754	3,528,658	1,516,574
1887, ...	6,417,148	7,559,518	4,023,953	1,567,622
1888, ...	6,489,738	7,998,969	4,337,121	1,683,349
1889, ...	7,603,642	8,322,824	4,387,504	1,733,964
1890, ...	9,202,703	7,904,214	4,563,025	1,970,160

	Metric Tons of 2,204 Lbs.			
Years.	*Austro-Hungary.*	*Sweden.*	*Belgium.*	*Russia.*
1866, ...	319,709	—	—	—
1867, ...	361,038	—	423,069	—
1868, ...	425,071	—	435,754	—
1869, ...	450,567	285,065	534,319	—
1870, ...	452,244	293,438	565,234	354,032
1871, ...	476,627	293,277	609,230	353,710
1872, ...	531,850	334,788	655,565	393,065
1873, ...	594,980	339,685	607,373	378,387
1874, ...	545,742	332,154	532,790	374,355
1875, ...	504,347	343,551	540,473	420,484
1876, ...	450,933	344,834	490,508	—
1877, ...	409,000	336,370	470,488	—

TABLE B.—(*Continued.*)

METRIC TONS OF 2,204 LBS.

Years.	*Austro-Hungary.*	*Sweden.*	*Belgium.*	*Russia.*
1878, ...	424,249	333,496	493,544	409,633
1879, ...	404,160	342,547	448,371	429,865
1880, ...	465,518	405,765	595,704	441,285
1881, ...	543,000	435,428	624,736	462,027
1882, ...	611,681	398,945	727,000	498,400
1883, ...	710,037	422,627	770,659	—
1884, ...	734,346	430,534	750,812	—
1885, ...	714,784	464,737	712,876	527,526
1886, ...	703,350	442,457	697,110	—
1887, ...	703,530	456,625	754,481	532,649
1888, ...	790,227	457,052	826,850	612,000
1889, ...	816,156	420,665	832,226	—
1890, ...	—	781,958	—	—

SOME OF THE AIDS TO AUGMENTED OUTPUT.

One of the factors which has aided in securing the output of 9,202,703 gross tons of pig iron in 1890 was that about seven per cent. of this never took the form of pig iron. The advances made in our large steel works demand economies in every department, and instead of running the metal from the blast furnaces into moulds in pig beds, allowing it to cool and then burning fuel to bring it again into a molten state, so as to feed it to converter or furnace, the iron is run from the blast furnace into ladles, carried on railway trucks and on these conveyed to the steel works for conversion into steel. Each year has shown an increase in the quantity of iron thus treated, and in the year 1890 fully 620,000 tons of molten iron was taken in this direct manner from blast furnaces to the steel converting plants.

When the practices of our great steel works are compared with the older methods, we understand why steel rails cost less than iron rails, or why steel plates undersell standard brands of plate iron. In these modern plants, the cold iron ore, fuel and flux enter the furnace and the cold or nearly cold finished rail is handled at the drill press or punch, but at no intermediate point in the manufacture is the metal produced cold or below a temperature for convenient manipulation in rolls or under hammers.

Inquiries addressed to our large steel plants indicate that the 620,000 gross tons of iron used direct in 1890; that is, carried in a molten state from the blast furnaces, will be much augmented; for one large mill using direct metal was idle on account of reconstruction one-half of 1890, and at another plant, the use of molten metal covered but two months of the year. We may also expect this practice to continue to expand in other special industries.

Another factor which has aided the development of the pig-iron industry is the association of the blast furnace and the chemical laboratory. The older empirical tests of bending a bar of iron to determine whether it was "cold short," "red short" or "neutral," or of noting the mere physical structure of fracture to recognize iron of foundry or mill grade, while serviceable still, have been supplemented by chemical analyses; and the percentage, or oftener the fractions of one per cent. of carbon, and the form in which it exists, of phosphorus, manganese, sulphur, silicon, etc., are now the generally accepted criterions of merit.

But the chemical laboratory would fulfil but a part of its functions without a practical and technical application of the results there obtained, and to the intelligent, progressive energy and conscientious attention to details which have characterized many of our blast furnace managers, the people of the United States are largely indebted for the position which our country has taken as a producer of pig iron.

As a rule, the efforts of this class (practically a creation to meet peculiar business requirements), are scarcely appreciated, for it is not only the manager, who, with well-equipped blast furnace and rich ores, makes a brilliant record, but also he, who with inefficient appliances, lean or refractory ores and varying mixtures, accomplishes what a few years ago would have been considered impossible, who should share in the credit of the good work accomplished.

The structural features and the mechanical appliances introduced have done much to advance the possibilities of pig iron production, and have given the means of constructing, operating and successfully handling the product of our large blast furnaces, while permitting the smaller plants to

work with greater economy. With the appliances in use at what were modern furnaces a quarter of a century ago, it would be practically impossible to handle the material supplied to, and the metal and slag flowing from, some of the larger blast furnace plants of to-day.

Another factor of importance in securing the present position of the United States as a pig iron producer is the study which the consumers have given to the character and qualities of the pig iron which they use. While this investigation has not been as general as is desired, outside of the steel works; there is a large share of credit due to the users of pig iron for the time and money expended in experimenting upon various grades and compositions of iron to secure certain results. Evidences of this are found in the American chilled car wheel, which, to meet the severe requirements of the service, must have a soft, tough hub, a hard, smooth tread, and yet be placed on the market at a cost which seems ridiculously low. One of our local manufacturers has published a record of tests of 10,000 chilled iron car wheels, made by a testing bureau, which shows that 8,690 did not vary one-twenty-fourth of an inch in diameter as they came from the chills, and, at that, an average of fifty blows of a weight of 140 pounds, falling twelve feet, was required to break 105 of these wheels (the number tested). The firm states that in none of the wheels was there a variation in depth of chill of more than one-eighth of an inch, and not a single wheel was rejected from the whole number offered for inspection because of any chill-cracks, blow-holes, or other imperfections of workmanship or material, and the metal in all the wheels broken, was found to be of a good, soft, open, gray in the plate and free from slag or dirt. The tread of every wheel was practically smooth, and not one needed to be ground, or in any other way made smooth or true.

Such an achievement is not the result of any "rule of thumb procedure;" it is the outcome of experimental and exhaustive laboratory and foundry tests, coupled with a patient study of mechanical appliances. The above instance is only given as one of many. It has been but a few years

since attention was directed to the remarkable influence which a small percentage of aluminum exerted upon cast iron, one-half of one per cent. being sufficient to make a material change in the physical features of the cast metal. The large amount of speigeleisen and ferro-manganese which has been produced and used in this country, makes familiar the influence of manganese upon iron, and has caused it to be studied thoroughly. A series of very careful tests and examinations as to the influence of silicon upon iron, and the manufacture of ferro-silicon has also attracted attention, and lately we have learned from official tests, of the influence exerted upon iron for armor plate by a small percentage of nickel.

All of this goes to indicate that attention has been devoted to the chemical and mechanical properties of iron by those who use the metal, thus increasing the demand.

It would be ungenerous, in noting some of the causes which encouraged the marvellous development of our pig-iron industry, to omit mention of the assistance rendered by organizations and by the technical and trade press. The generous interchange of experiences brought about by social acquaintance, the reading and discussion of papers at the meetings of technical, engineering and trade organizations, have been of great assistance to many who control our blast furnaces. The liberal publication of technical and commercial data has, through the medium of a number of special publications, lifted many out of ruts which they would naturally follow in practically isolated locations without the knowledge of what was accomplished and how results were attained elsewhere. The collection and prompt publication of statistical information has been of marked service, and much of the data presented in this lecture is proof of the value which the manufacturers of pig iron place on this feature. Without their cordial coöperation and confidence, this data would not be obtainable, and with their active interest, the publication within four weeks of the complete statistics of pig iron production for the year 1890 is most creditable to Mr. Swank and his associates in the American Iron and Steel Association. The figures

represent returns from the 562 blast furnaces of the United States, now considered as active; they give the number of furnaces in blast or idle, with the amounts of iron made by different fuels and of special character in each producing State, and in some instances, of districts in a State, and the stock of iron on hand is also given in the same detail.

THE BLAST FURNACES.

The blast furnace (a structure either built of stone masonry or excavated out of the solid rock), about 30 feet high, having a bosh of 7 or 8 feet in diameter, had grown in 1866 to a more pretentious structure, where a height of 60 feet and a bosh diameter of 16 to 17 feet was attained, but in a majority of cases, the masonry structure was maintained, although brick displaced the stone to some extent, and the boilers and hot blast stoves were often erected upon heavy and expensive arches or carried on side hills supported by massive retaining walls. The output of twenty to thirty tons per week had grown to 150 or 200 tons in 1866.

The blast furnace of to-day, producing five times the amount of iron, costs little more than the furnace of twenty-five years ago, and is a more convenient, more shapely and a better equipped plant.

Probably no better illustration of the development of the blast furnace can be offered than the following memoranda concerning the largest plant in Pennsylvania, viz: that of the Edgar Thomson Steel Works.

This plant consists of nine blast furnaces, which can produce together over 2,000 tons of pig iron daily, and lately have averaged a total output of between 1,500 and 1,600 tons per day. One of the furnaces, which is chiefly used for producing spiegeleisen and ferro-manganese, is 65 feet high with a bosh diameter of 15 feet; two of them are 80 feet high with boshes 20 feet in diameter; two are 80 feet high with boshes 22 feet in diameter; two are 90 feet high, with boshes 22 feet in diameter, and two are 80 feet high, with boshes 23 feet in diameter. Twenty-six blowing engines supply blast for this group of furnaces. All of the engines have blast cylinders, 7 feet in diameter, and are of 4 and 5

feet stroke of piston. One hundred and sixteen boilers furnish steam to drive the blowing engines, the pumps and hoisting appliances, and twenty-four pumps are in constant use, furnishing water. Thirty-three hot blast stoves heat the air supplied.

One of these furnaces has reached the remarkable output, for a single day, of 457 gross tons of iron, in a week one furnace stack has made 2,462 gross tons, and in a month one stack produced 10,164 gross tons; that is, in one month, one of these furnaces produced fully as much iron as twenty-five years ago would have been turned out in a year from the best and largest of the American blast furnaces. This is not due alone to the equipment nor even to the equipment and management, unless in the management is included the appreciation by the owners of the value of using richer ores and of paying for the preparation of the ore used, so as to increase the percentage of iron.

The number of blast furnaces in the United States is now less than has been reported at any time for the past twenty years. (See Table A.) Notwithstanding the new plants added, the active list of 1890 numbers eight less than that of 1889. The increased output of pig iron is due to larger average dimensions of the furnaces, better equipment and improved management.

By reference to the table of the total number of furnaces, and those in blast at the close of various years (see Table A), it is evident that the largest number of furnaces in any year was 1877 and 1881, when 716 were on the active list. Since that time there has been a gradual decrease in the number, owing to the older and smaller furnaces which had no possible future, dropping out. The largest number in blast at one time was in 1881, when there were 455; the smallest number was in 1876 and 1884, when 236 only were in operation.

We have no reason to anticipate a serious break in our growth in population, and as we increase in numbers, more iron will be necessary. If our general prosperity continues, the augmented wealth of the nation should encourage a greater production of pig iron per capita.

A considerable portion of our country is inadequately supplied with transportation facilities, the extension of railroads will build up new towns, towns will grow into cities, each commanding an increase in the pig iron product, both for railway connections and local requirements.

CENSUS FIGURES.

The development of the pig-iron industry, as indicated by census returns for the years 1870, 1880 and 1890, is as follows: 9,579,779 net tons are reported by Dr. Wm. M. Sweet, special agent in charge of the iron statistics for the eleventh census, as the output for the United States for the year ending June 30, 1890.* This is equivalent to 8,553,374 gross tons. It shows that from 1880 to 1890, the production of pig iron increased 153 per cent., while from 1870 to 1880, the production was augmented eighty-five per cent.

The general distribution of this production in the three census years, 1870, 1880 and 1890, is exhibited by Table C.

TABLE C.

Production of Pig Iron in the United States according to Census Returns.

	Tons of 2,000 Lbs.		
Districts.	*Year Ended May 31, 1870.*	*Year Ended May 31, 1880.*	*Year Ended June 30, 1890.*
New England States, . . .	34,471	30,957	33,781
Middle States, ...	1,311,649	2,401,093	5,216,591
Southern States, ...	184,540	350,436	1,780,909
Western States, ...	522,161	995,335	2,522,351
Far Western States, . . .	—	3,200	26,147
Total, ...	2,052,821	3,781,021	9,579,779

PROSPECTIVE DEVELOPMENT.

Having discussed the past and considered the present, attention may be devoted to the future of the pig-iron industry, and the question naturally arises will this development continue in the same ratio; that is, will the next twenty-five years show as marked growth, or what will

* The apparent discrepancy between the figures of Messrs. Swank and Sweet is due to the different intervals covered by their reports.

that growth be relatively to the twenty-five years past, which are especially covered in this lecture. It has been shown that the output of 1890 was seven and five-eighths times that of 1866, and that to make the same advance in the next one-quarter of a century, it would demand a production in 1915 of over 70,000,000 gross tons of pig iron. This we do not expect to attain. If we take the last two decades, we find that our pig iron output has increased over five and one-half times, and this rate would make the production in 1910, two decades hence, exceed 50,000,000 gross tons. Neither is it presumed that we will reach this figure. In the last decade, we have augmented the output nearly two and one-half times; a similar increase in the coming decade would make the production of pig iron in 1900 22,000,000 gross tons, which would also represent a large rate of increase. It must be remembered that a portion of the later development has been abnormal, and is not to be credited to augmented consumption. Some of the late increased production solely of pig iron is due to the restrictions of importation, which will hardly be again removed, unless by legislation, which would greatly damage the industry; and lately, considerable development has been associated with real estate speculative schemes, which will be apt to exert a restricting influence in the near future. But while it is not probable that either of the figures above-mentioned will be reached in the intervals of time indicated, if political action does not disturb the industry, or if labor troubles do not seriously interfere with developments, there seems no reason for expecting that the pig-iron industry will remain dormant, but we may rather look for a nearly steady growth which, at the expiration of twenty-five years, will probably make the annual requirements of the United States, in pig iron or its equivalent, amount to between 20,000,000 and 25,000,000 gross tons.

Fortunately, we can only surmise as to the future, but these figures are the result of a careful study of statistics, taken in connection with an intimate knowledge of the present state of development and a personal acquaintance with the possibilities of various portions of the country.

There will be times of depression followed by others of unusual activity, but we may confidently look forward to a material advancement, perhaps greater than I estimate, but certainly much more pronounced than was believed possible ten years ago.

[*To be continued.*]

LOUIS H. SPELLIER.

The subject of this memoir was born in Hanover, Germany, on January 6, 1841, and died in Philadelphia, August 22, 1891, in his fifty-first year.

He received a good technical education in the schools of his native city, and afterwards learned the trade of watch- and clock-making with his father, Frederick Spellier. Shortly after attaining his majority, he came to this country, locating first at Doylestown, in Pennsylvania, where he practised his handicraft until the year 1880, when he removed to Philadelphia. It was whilst living at Doylestown that he applied his leisure time to the study of electric clocks and time-telegraphy, in which field of invention he afterwards achieved a distinguished position.

The record of his inventions is given in the following:

In 1874, he exhibited, at the exhibition of the Franklin Institute, a large clock of his own handiwork, to which he had applied an improved escapement. For this he was awarded a silver medal.

The same invention was recognized by the judges of the Centennial Exhibition two years later, by the award of a medal.

Encouraged by these recognitions of his ingenuity, he continued to work assiduously in his chosen field, and shortly thereafter developed a system of time-telegraphy for which he secured, at intervals, letters-patent of the United States, covering the following subjects, viz: an electric motor for clocks, a sparkless circuit-breaker and a contact-maker for electric clocks. These patented improve-

ments completed an electric clock, or system of electric time-telegraphy, the merits of which were fully recognized in the leading technical journals of the United States, France, Germany and England, and in the recent works on the subject, in several of which Mr. Spellier's inventions are deemed of sufficient importance to be described as constituting a distinctly original system.

The Franklin Institute, through its Committee on Science and the Arts, testified to the value of Mr. Spellier's inventions by awarding him the Elliott Cresson Medal, in 1881, for his improved escapement; and in 1884, on the recommendation of the same committee, he received from the Board of City Trusts the John Scott Legacy Medal and Premium for his electric-clock system.

The Spellier patents were lately acquired by a Philadelphia company, and the system has been for several years in service in this city.

Mr. Spellier visited his native place last year, chiefly for the benefit of his health, which had become impaired by constant and close application for years. Upon his return, he applied himself to perfecting the invention of a self-winding electric clock, of which he had completed a second model only a few weeks prior to his death, and had made application for a patent. Those who have had the opportunity of inspecting this last work of Mr. Spellier, speak highly of its merits.

Mr. Spellier's ability as an expert in his special branch was recognized by the publishers of the new edition of the *Iconographic Encyclopædia*, in the sixth volume of which appears an admirable article from his pen on "Time Telegraphs."

Mr. Spellier was elected a member of the Franklin Institute in 1874, and was always warmly interested in its work. He was a regular attendant of its meetings, and served for a number of years upon the Committee on Science and the Arts, of which he was a member at the time of his death.

Personally, Mr. Spellier was courteous and unassuming in manner and the possessor of a cheerful, kindly and amiable disposition, which gained for him the warm esteem of

his associates and fellow-members. His death, following a very brief illness, was entirely unexpected.

WM. H. WAHL, *Chairman.*
ARTHUR BEARDSLEY.
W. M. MCALLISTER.
EDWARD F. MOODY.

PROCEEDINGS

OF THE

CHEMICAL SECTION

OF THE

FRANKLIN INSTITUTE.

[Stated meeting, held at the Institute, Tuesday, October 20, 1891.]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, October 20, 1891.

Dr. W. H. WAHL, President, in the chair.

Mr. W. N. Allen, No. 2 Chestnut Street, Philadelphia, was elected a member of the section.

Upon motion it was voted that the section cause to be printed a form of letter to be used by the Secretary for the purpose of informing newly-elected members of their admission to the section.

A letter from Mr. Otto Lüthy was read, announcing that illness prevented him from attending the meeting. The paper which was to have been presented by him was therefore deferred to a future meeting.

Dr. Bruno Terne read a valuable and highly interesting paper on "The Utilization of the Bye-products of the Coke Industry."

The paper was illustrated fully by lantern projections. The paper called forth an extended discussion, in which Dr. Jayne, Mr. Henry Bower, the author and the President took part. The paper and discussion thereon were referred for publication in the *Journal.*

Dr. E. F. Smith presented a paper by himself and Mr. Hough, of the University of Pennsylvania, on (I)—"The Iodation of *p*-Bromobenzoic Acid," and (II)—"Salts of *p*-Bromo-*m*-nitrobenzoic Acid." It was read by title and referred for publication in the *Journal.*

Adjourned.

WM. C. DAY, *Secretary.*

NOTES ON SOME CASES OF DRINKING WATER AND DISEASE.

By William P. Mason.

[*Read at the stated meeting of the Chemical Section, held May 19, 1891.*]

Drinking water and disease, upon which I am expected to speak to-night, is a question of such exceeding breadth, that so considerable a title certainly outweighs the small amount of matter capable of being placed within the compass of a short paper. I therefore beg to present only some few facts which have come within my own experience, and certain other matter bearing directly thereupon.

In that most excellent treatise upon "Water Supplies and Inland Waters," recently issued by the Massachusetts State Board of Health, waters are classified into "normal" and "polluted," the former being such as are free from addition, directly or indirectly, of either sewage or industrial waste.

The relation of "normal" waters as a class, to sanitary science, constitutes a subject by itself, and one by no means completely understood, as is instanced by the doubt we entertain of the effect of fresh water algæ upon our city supplies. However objectionable such growths may be from an æsthetic point of view, owing to the disagreeable odors generated, we must nevertheless confess to much ignorance as to their pathogenic importance. It has been my fortune to meet with but few cases of illness traceable to normal waters, and in all such instances the patients suffered from a mild and transient form of diarrhœa, caused by water from a low-lying small lake or pond, surrounded by low wooded banks. Of course, as in the experience of other water analysts, the commonly reported cases of algæ have been met with, but no material has so far been secured whereby disease could be traced to their presence. We will all look with interest to the results of the investigation now

being undertaken by the American Water Works Association, and we hope for further light upon this point.

As concerning the second division referred to above, namely, polluted waters, permit me, for the moment, to make a further subdivision, and consider the admission of sewage from pathological sources, as distinct from that derived from healthy persons. I ask for the distinction because without it, it would often be hard to account for the long-continued immunity from disease, enjoyed by people who habitually make use of waters which are unquestionably grossly polluted.

How often do the cases of contaminated city wells illustrate this point, and how frequently is the chemist met by this refuting "test of experience," when he knows not only from the results of his own analysis, but from personal inspection of the vaults in the neighborhood, that such wells drain sources of outrageous filth. In view of the over-taxed purifying powers of the intervening soil, there is but one way out of the dilemma, and that is that sewage from pathologic sources has as yet not chanced to reach these wells, or else that such persons as swallow specific germs do not, at the time, furnish suitable ground to grow the seed which disease has planted.

You will remember that Emmerich made very light of the objections raised against ingestion of sewage material, and even went so far as to personally consume no inconsiderable quantity of it daily, and induced some students of his to do likewise. In contrast with his physiological results, permit me to relate a somewhat interesting case with which I was connected.

Rain-water, from a cistern of the filtering type, situated upon carefully managed property, had been in use for some years. Suddenly, with little warning, the entire household, one person excepted, were taken ill. The symptoms varied from intense nausea to great, if not dangerous, prostration. The one person who escaped illness was the only one who did not use the water. Among those attacked were several children.

Upon investigation, both cistern lining and private sewer

were found defective, and permitting of more or less direct communication. Up to the time of the outbreak none of the household had suffered from diarrhœa or kindred troubles, nor could I obtain any history of recent disease of any kind. The children attacked were on a short visit only. The point to be emphasized in this case is that the sewage which caused the trouble was "normal." Although I secured an analysis of the water at the time illness was produced, it is to be regretted that no previous analyses were on record, which might have established some relation between the figures of the analysis and the "poisoning point" of the water.

The serious evils lurking in water containing sewage derived from sources of disease, are too well-known to need enlarging upon here, and the dangers to be dreaded from the improper disposal of city drainage, is one of the widely-talked-of topics of the day.

Much has been said and written upon the ability of sewage-laden streams to purify themselves, and authorities of great weight are to be found on either side. Some time since a series of analyses were undertaken, as you will remember, by Dr. Long, of Chicago, upon the dilute sewage contained in the Illinois and Michigan Canal. It is to be noted that this canal receives its supply of water (or rather dilute sewage) at Bridgeport, where the pumps deliver to it the filthy water of the Chicago River, contaminated with a great portion of the sewage of Chicago. From Bridgeport the water "flows along the level to Lockport, twenty-nine miles below, requiring about a day for its passage." It receives no dilution on the way and is frequently agitated by passing boats. "After passing Lockport the water descends to Joliet through four locks, and falls over a dam seven feet in height to point of collection. There is a fall of 58·2 feet in a distance of four miles, and no dilution takes place on the way." The experiments with this canal water have been both numerous and thorough, and judging from the mean results there is good ground for the statement that very considerable self-purification takes place during the flow of thirty-three miles.

I have long been of the opinion, however, that what may be very true for dilute sewage, does not hold good as we approach the limit of potable water.

In other words, so far as purification of a water by the natural processes of oxidation is concerned, I believe that the rate of such purification varies directly as the amount of sewage contamination. Given a stream with a certain amount of pollution, the per cent. of such pollution which must disappear per mile of flow, will continually decrease as the stream flows on. To return to Dr. Long's figures. The analyses as given by him are as follows, in parts per million:

At Bridgeport:

	Free Am.	*Albu. Am.*	*Oxygen Consumed.*
June 26,	2·6	0·64	12·0
July 3,	2·7	0·52	6·8
17,	25·0	1·50	22·4
24,	5·5	0·37	12·6
31,	23 0	1·76	23·2
Aug. 7,	26·0	1·50	16 8
14,	29·0	1·64	32·0
21,	27·2	1·50	28·0
28,	29·2	1·90	35·2

At Lockport:

June 26,	2·8	0·56	11·36
July 3,	2·4	0·42	7·20
17,	10·2	0·72	12·80
24,	9·2	0·47	14·80
31,	11·0	0·72	10·70
Aug. 7,	12·0	0·48	9·60
14,	15·2	0·88	9·76
21,	15·0	0·84	10.80
28,	13·0	0·88	12·40

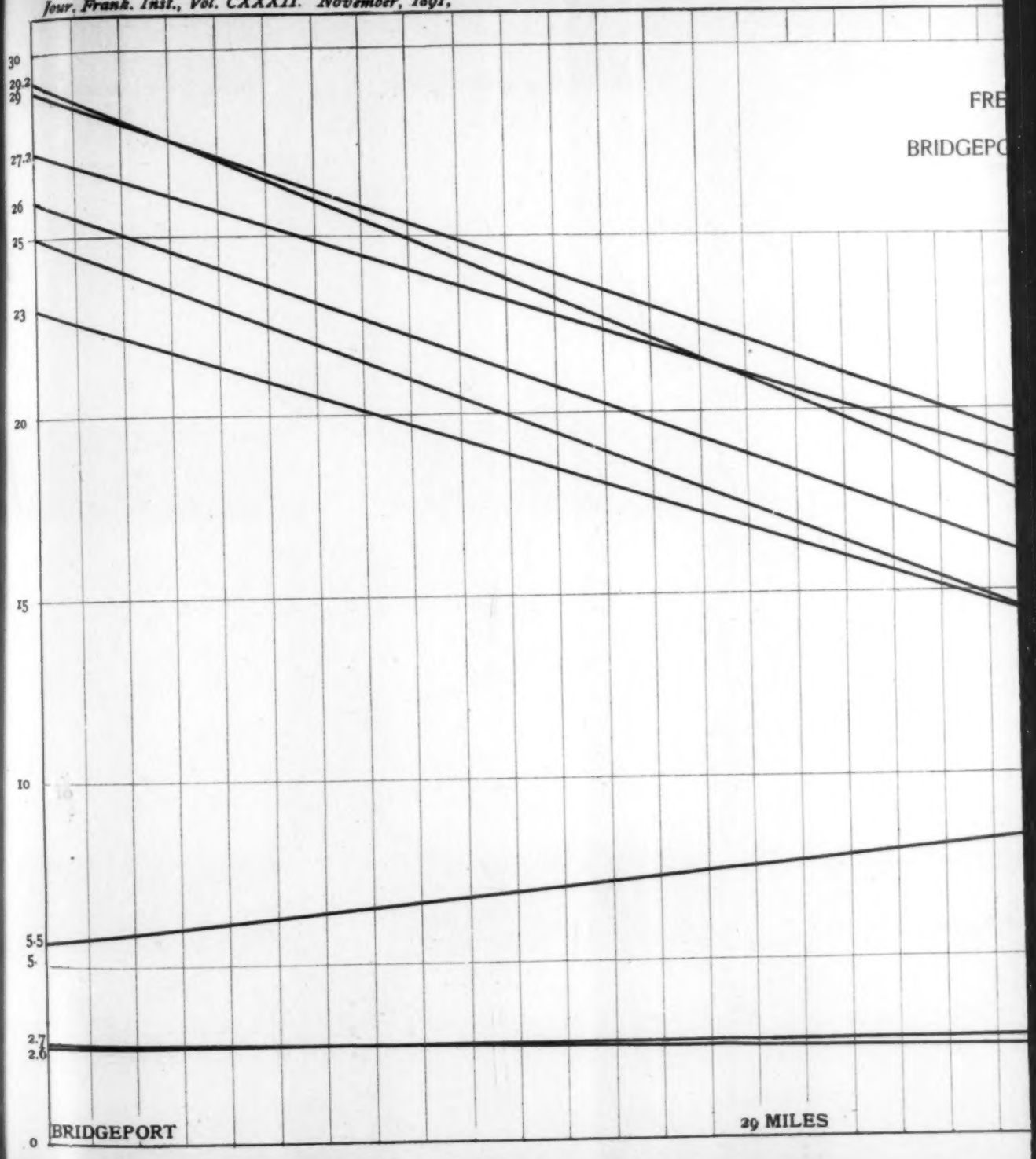
At Joliet:

June 26,	1·7	0·46	7·36
July 3,	1·8	0·46	9·76
17,	13·0	0·44	14·50
31,	9·2	0·44	5·68
Aug. 7,	7·5	0·42	5·84
14,	9·8	0·46	5·76
21,	9·0	0·11	0·52
28,	8·0	0·32	6·80

Plating these in graphic form they assume the shape shown on the accompanying charts. The change in lake level at various dates, together with other disturbing influences, caused comparatively clean water to reach the pumps at times, and we, therefore, are furnished with data governing the purification of several variously contaminated waters, while flowing under constant conditions.

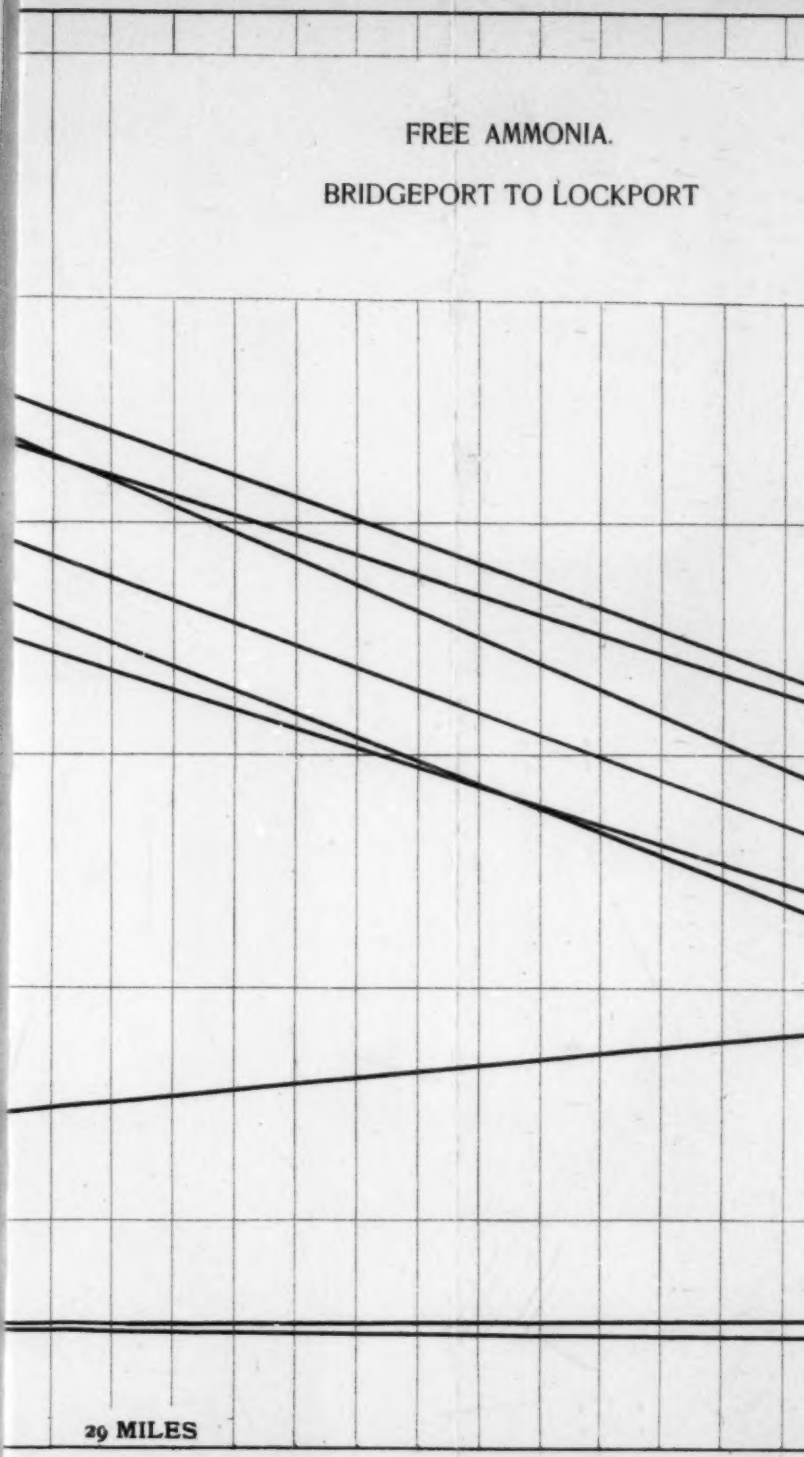
It will be noticed that the rate of purification per mile for the more grossly contaminated samples, is much greater than that for those comparatively pure. Thus, during the flow from Bridgeport to Lockport the sample of July 3d loses 11·2 per cent. of its free ammonia and 19·3 per cent. of its albuminoid ammonia, while the sample of August 28th loses 55·5 per cent. free ammonia and 53·7 per cent. albuminoid ammonia while flowing the same distance.

Even the best of these waters of the Illinois and Michigan Canal is very far from being potable, and we may consequently look for still further reduction in the purification rate as we near the potable limit. My experience with the waters of large streams contaminated with city sewage, for instance, the Hudson River, is that self-purification is exceedingly slow. Having been employed by the Board of Health to examine into the quality of the Hudson River water opposite Albany (which water, taken directly from the side of the wharf, constitutes the present city supply), I made a very thorough examination of that section of the river. Permit me to digress here for a moment to state that it is my conviction that analyses of water from any one spot in a large stream, are valueless for the purpose determining the continued presence of up-stream contamination. The dilution is commonly much too great to permit the sewage revealing itself. The Albany case is one in point. In order to determine whether Troy sewage, entering six miles above, was felt at the Albany intake, the river water was first sampled above Troy and then below the Troy sewer outfalls, where no one would hesitate to say that contamination was serious. A difference was noted between the two results which was undoubtedly caused by the influx of the Troy and Mohawk River sewage.

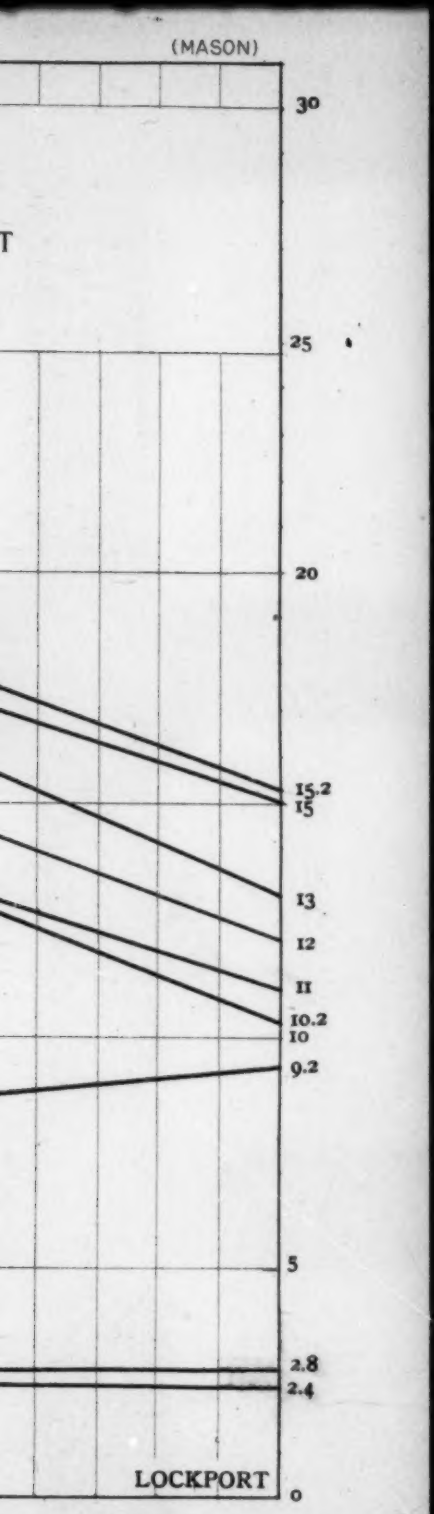

30
29.2
29
27.2
26
25
23
20
15
10
5.5
5
2.7
2.6
0
FRE
BRIDGEPO
BRIDGEPORT
29 MILES

FREE AMMONIA.

BRIDGEPORT TO LOCKPORT



29 MILES


(MASON)
30
T
25
20
15.2
15
13
12
11
10.2
10
9.2
5
2.8
2.4
LOCKPORT
0

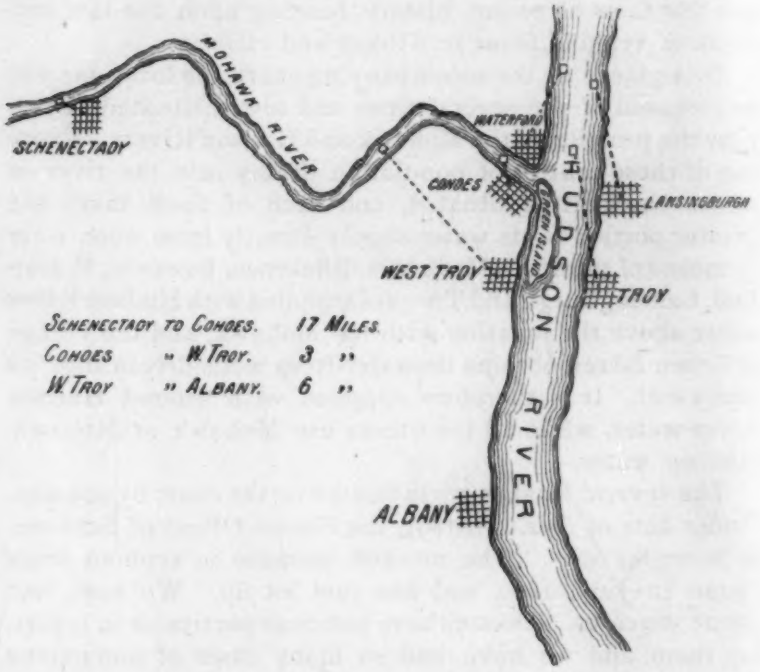
Upon continuing the collection of samples, every mile there were obtained analytical results which showed that the difference between the waters above and below Troy was largely maintained when Albany was reached. On the strength of the maintenance of this difference, rather than upon the results of any separate analysis, I pronounced against the Albany water supply as being contaminated with sewage from up-river sources. Directly relating to what has been referred to, let me finally ask your attention to a few facts of recent history, bearing upon the late outbreak of typhoid fever in Albany and vicinity.

By a glance at the accompanying chart, the locations will be observed of the several cities and towns situated at and near the junction of the Mohawk and Hudson Rivers. Every one of these centres of population drains into the river on whose banks it is situated, and each of them takes the greater portion of its water supply directly from such river by means of pumps. Mark this difference, however, Waterford, Lansingburgh and Troy are supplied with Hudson River water above the junction with the Mohawk, and the village of Green Island obtains its water from wells driven into its sandy soil. It is therefore supplied with filtered Hudson River water, while all the others use Mohawk or Mohawk-Hudson water.

The several intakes are indicated on the chart by squares. Under date of April 11, 1891, the Health Officer of Schenectady writes me: "The marked increase in typhoid fever began in July, 1890, and has just let up. We have had about 300 cases. Doctors have not been particular in reporting them, and we have had so many cases of anomalous fevers, that diagnosis is questionable. Seventy deaths have been reported." Permit me to say that it has not been the rule during this epidemic, for physicians to do their whole duty in reporting cases. I know of one instance in which only two or three cases were reported out of twenty-five. Schenectady is a very old town (of 20,000 inhabitants), and its sewerage system is doubtless none of the best, but its drainage eventually reaches the Mohawk and is carried onward with the current.

The following information was obtained from Dr. Leo, Health Officer of Cohoes, and from Dr. Peltier, his predecessor. Population of Cohoes is 22,000.

The epidemic of typhoid began in Cohoes about the end of October, 1890, and ceased about the middle of the following March. Altogether there were about 1,000 cases. The cases were mild in character, resulting in very few deaths. Cohoes takes its entire water supply from the Mohawk and



returns its sewage into the same river. Boiling of water for drinking purposes was recommended, and no typhoid developed among families who followed the recommendation, except in those instances where members of such families drank unboiled water while at work away from home. A portion of the city is owned by the great Harmony Knitting Mills, and is built up with tenements for their employés, of which there are many hundreds. These tenements are

kept in excellent repair and the plumbing is the best in the city, but extends to kitchen sinks and drains only. No water-closets are employed, as each house is furnished with privy vault in back yard. Typhoid was especially bad in this quarter. The Cohoes Health Officer has professional occasion to visit in Waterford (population 5,400) and in Lansingburgh (population 10,000), which towns are connected with Cohoes by bridges. He reports that hardly a case existed in either of those towns, and it is to be noted that they draw water from the upper Hudson above the Mohawk junction.

West Troy is situated on the Hudson and sewers therein, but by aid of the chart it will be noticed that its water supply comes from the Mohawk some distance above Cohoes. Its population is 13,000. The following information was obtained from Dr. McNaughton, health officer:

Epidemic of typhoid began the last of November. At meeting of Health Board, about December 15th, fifty cases were reported. Of these, forty-two had used Mohawk water, the remainder well water. On December 20th, the Mohawk supply was shut off and arrangements made with the town of Green Island (which village, by the way, had no fever) to use a portion of its supply of filtered Hudson water. One week thereafter the weekly report of cases showed fifteen, and the second week thereafter but one case was reported. The Green Island supply was used one month. Upon returning to the Mohawk supply in the middle of January, a slight increase in typhoid was observed. Total number of cases exceeded 100. The fever, as in other places, was very mild, resulting in ten deaths. Troy is situated directly opposite West Troy. Its population is 60,000. Its water supply comes partly from lakes back in the hills, partly from the Hudson above the Mohawk junction.

There have been very few cases of typhoid in Troy during the past year, and of those few a large percentage were imported from Schenectady and West Troy.

Troy dumps 8,000,000 gallons of sewage into the Hudson daily.

Six miles below Troy is the city of Albany; population, 100,000. Albany takes its water through an intake in the side of the wharf, directly in front of the city. Not only does sewage from the upper Hudson and Mohawk flow towards it, but during flood tide and south wind, the return of its own sewage from the sewer outfalls below has been proven by the floating of buoys.

The typhoid epidemic began in Albany the last of December, 1890. The disease was very mild in character, resulting in sixty-two deaths during the months of January, February and March, 1891. The total number of typhoid cases reported during the same period is 411, but this figure I have reason to know is absolutely unreliable. Albany experienced a very serious epidemic during the past winter, and the alarm was widespread, of that there can be no question. A small portion of the city receives its water supply from an inland gravity source. Typhoid was not nearly so plenty in that section, only eighteen cases being reported to the end of March.

An attempt has been made to fix the Albany epidemic upon the bad sanitary conditions of the house drains, whereby sewer air was admitted into the dwellings. In one section visited, sixty-five houses out of seventy-five possessed drains which leaked sewer air, and at the Albany Penitentiary, where the drainage system is perfect and where the inmates drink unpurified river water, there occurred no case of typhoid.

Faulty drainage, permitting the inhalation of sewer air, doubtless would induce a condition of the system favorable to the propagation of the typhoid germ should it be introduced, but it must be remembered that Troy has sanitary surroundings and appliances fully as undesirable as Albany, yet no epidemic occurred there.

Possibly the excellent sanitation at the penitentiary maintained the inmates in a condition of health such as to resist the planting of the disease.

Finally, as I am informed by Dr. Craig, of Albany, at Van Wie's Point, four miles below Albany, the laborers employed in cutting ice for the great ice-houses, had typhoid

fever break out among them during January. They used river water for drinking purposes.

To conclude, typhoid germs have been carefully looked for in the water and have not been found. But in view of the relative volumes of a city water supply and a sample for bacteriological examination, such a result does not appear surprising. There are those who hold that this outbreak of typhoid fever is to be explained in some other way than by attributing it to a contaminated water supply, but when we bear in mind that, out of this group of closely situated cities and towns, all of those which used the Mohawk-Hudson water contracted the fever, and that all those which did not use such water escaped, there is much food for thought.

RENSSELAER POLYTECHNIC INSTITUTE,
TROY, N. Y., May 18, 1891.

THE USE OF CADMIUM IN ASSAYING GOLD BULLION.

BY CABELL WHITEHEAD, Assayer to the Mint Bureau.

[*Presented at the stated meeting of the Chemical Section, held Sept. 15, 1891.*]

Cadmium, as a substitute for silver in assaying gold bullion, was first used by Balling.* He states that the gold is entirely parted from all metals, except the platinum group, when its alloy with cadmium is boiled with strong nitric acid for one hour, followed by a second boiling for ten minutes with fresh portion of same acid. For general assays of gold bullion I do not think that Balling's method with cadmium will bear comparison in point of accuracy with the old one of quartation with silver and cupellation. But, with certain modifications which will be suggested later, it will be found rapid and satisfactory for a preliminary assay.

It is, however, in the estimation of small quantities of silver in gold bullion containing considerable amounts of copper or platinum, that I have found cadmium to be a most efficient aid.

* *Crook's Select Methods of Chemical Analysis.*

The difficulty in determining silver in the presence of platinum by cupellation is well known to assayers. In such cases the following has been the method in the United States Mint at Philadelphia:

An approximate assay is made by cupellation, after which, and based on this approximation, enough pure silver is added to 500 mgs. of the bullion to make in all at least 1,004 mgs. of silver present in the assay. This weighed silver and bullion is wrapped in a sheet of lead weighing 2·5 gms., and the whole placed on a hot cupel in the muffle furnace.

As soon as the lead "clears" the cupel is withdrawn, when cold the button is flattened and put in a bottle such as is used in the humid assay of silver, dilute nitric acid is added and heat applied. When action ceases, the silver present in solution is determined volumetrically as usual. The silver found, less the amount added, gives the silver in 500 mgs. of bullion.

There are two objections to this method: (1) The insolubility of lead nitrate in nitric acid necessitates the use of dilute acid, which leaves much alloy with the gold; (2) the alloy to be removed is one-third silver. This is very important when small quantities of silver are to be determined, as in the case of gold coin, which rarely contains more than ·003. Cornets, after three boilings with acid (ten minutes each), retain from ·001 to ·002 of silver; so it will be seen at a glance that the amount retained after one boiling with dilute acid will be much greater and the gold residue will contain more silver than was present in the original bullion.

The presence of ten per cent. or more of copper in high grade gold bullion makes the accurate determination of silver by cupellation impossible. Not only is gold taken into the cupel in large quantities by the copper, but it is also left in specks over the entire surface covered by the assay, thus making a "proof" practically worthless.

The method which I am about to describe, was devised for the estimation of silver in gold coin, and has been in use in the laboratory of the Bureau of the Mint for the past

year, where it has given such satisfactory results that it is thought a brief description may prove of interest to others engaged in the same line of work.

Five hundred mgs. are weighed into a porcelain crucible and covered with ten gms. of potassium cyanide. The potassium cyanide is melted over a Bunsen burner or preferably a blast lamp. When the cyanide is in quiet fusion one gm. of cadmium is dropped into the crucible, where it quickly melts and forms a bright, homogeneous alloy with the gold. After gently shaking, so as to bring the cadmium in contact with every particle of bullion, the crucible is removed and the contents poured on a clean porcelain slab, where it soon solidifies. The alloy will be found in one piece and is easily detached from the potassium cyanide. It is now washed in warm water, dried and placed in a diamond mortar, when several sharp blows with a hammer quickly reduce it to powder.

This powder is carefully transferred to an assay bottle, 1004 mgs. of pure silver added and 10 cc. of nitric acid—32° Baumé—poured on. In from five to ten minutes (depending upon the heat used) the solution is complete and all action has ceased. The bottle is now cooled and 100 cc. of normal salt solution is charged and the bottle shaken. The precipitation is finished with the decinormal solution.

This assay is accompanied by another called a "proof," made of 1004 mgs. of pure silver dissolved in the same amount of acid. Now the excess of silver found in the assay over that shown in the "proof," is the amount contained in 500 mgs. of coin. This doubled gives parts of silver per thousand.

Example: An alloy composed of 499 mgs. pure gold, one mg. of silver and one gm. of cadmium, treated as above described, after being charged with 100 cc. normal salt solution, required five cc. decinormal solution for complete precipitation of the silver present. A proof assay, carried along as check, upon 1004 mgs. of pure silver, required in addition to 100 cc. of normal salt solution, four cc. of decinormal solution for complete precipitation = to 1004 cc.

decinormal solution. Hence, each cc. decinormal equals one mg. silver, and one cc. decinormal solution required by the bullion, in excess of that called for by the silver added, shows the bullion to contain one mg. silver in 500, or two parts per thousand.

It may be asked by those not familiar with mint appliances and usages, "Why not titrate directly the silver brought into solution with the cadmium instead of adding a known weight of pure silver and finding the desired result by difference?"

The reply is that the small amount of silver present in this class of bullion would, as chloride, not "clear" on shaking, and much time would be consumed in finding the end reaction. By the method described the usual apparatus and solutions may be availed of and results rapidly obtained.

When no such reasons exist the sulpho-cyanide method alluded to at the end of this article is recommended.

EXAMPLE IN GOLD BULLION.

An approximate assay gives by cupellation ·035 silver, hence, 500 mgs. will contain about 17·5 mgs. of that metal, and 986·5 mgs. must be added to bring the total silver up to 1004 mgs. If copper is not present, about 50 mgs. is added, it being found that the alloy of copper with cadmium is very brittle, and the resulting button is easily crushed to powder.

The sample having been fused with cadmium in presence of potassium cyanide is powdered and subjected to treatment with nitric acid as above described.

After charging with 100 cc. normal salt solution, and shaking, the assay required 4·5 cc. decinormal solution for end reaction. A "proof" consisting of 1004 mgs. pure silver in solution, treated in same manner, required but three cc. decinormal solution.

Hence the assay contained 4·5 — 3 = 1·5 mgs. more silver than the proof, or 1004 + 1·5 = 1005·5 mgs. in silver in all. This, less the 986·5 mgs. silver purposely added gives nineteen mgs. as the silver present in 500 mgs. of

bullion taken, or thirty-eight parts in each thousand instead of thirty-five parts found by cupellation.

In favor of the new method it may be said:

(1) That the ready solubility of cadmium in nitric acid of any strength, makes it possible to dilute (if the term may be used), the silver present in gold bullion, to any desired extent, while on the other hand the difficult solubility of lead necessarily limits the dilution possible by the time required for its even imperfect extraction.

The inevitable small portion of other metals retained by the gold after treatment with nitric acid may therefore, by the use of cadmium, be made to contain but an infinitesimal quantity of silver.

(2) The brittleness of the button obtained, permits its being crushed to a powder, in which condition the alloy rapidly yields its soluble portion to nitric acid, and the time required for an assay is materially shortened.

(3) The low temperature required enables the chemist to dispense with all special appliances. A Bunsen burner will well answer the requirements for heating purposes, and little more is needed beyond a standard salt solution. No muffle or rolls are wanted.

In a laboratory where few assays are made the following method might be followed and very satisfactory results obtained. After alloying and crushing, treat in a parting flask with fifteen cc. of nitric acid 32° Baumé for ten minutes, pour off this acid into a beaker, add fifteen cc. acid same strength and boil for ten minutes longer, pour off again in same beaker, wash with hot water and take out in an annealing cup, dry and heat over blast lamp, weigh and deduct ·25 mgs. for cadmium retained. Twice this weight gives the gold fineness.

The acid and washings are evaporated to drive off free nitric acid, and silver determined either as chloride, or volumetrically with sulpho-cyanide with ferric indicator. Cadmium nitrate does not interfere in the least with determination of silver, either as chloride or as sulpho-cyanide.

"PRESERVALINE," A NEW PRESERVATIVE FOR MEAT.

By Dr. Bruno Terne.

[*Read at the stated meeting of the Chemical Section, held May 19, 1891.*]

Some time ago, I was applied to for information as to how to pickle meat without the use of nitrate of potash or saltpetre. The objections to the use of saltpetre are said to be:

(1) The operation of curing takes too long a time.

(2) It renders the outside of the meat hard.

"There is a compound," my inquirer said, "that is used in large quantities in the West, and which avoids both these objections. What is it?"

I informed him that if he would procure me a sample of this material, or would, in lieu of this, furnish me either with a specimen of meat prepared with it, or with some of the pickle as prepared for use, I might be able to throw some light upon the subject.

Shortly after this, I came into possession of two samples both in pulverulent form, one red and the other white in color. I exhibit specimens of both of these preparations. From another source I learned that this product was placed on the market under the trade name of "Preservaline."

A qualitative test showed conclusively the absence of all nitrates and the presence of boracic acid in combination with a base, for the reason that the characteristic green coloration of the flame only appeared after the addition of a drop of sulphuric acid. It appeared further that both the red and white samples had the same composition, with the sole difference that to the colored sample there had evidently been added some rosanilin color.

I made up a sample with a little rosalic acid which exhibited nearly the same color as the original one but a little more pronounced.

The quantitative analysis of the white sample gave:

	Per Cent.
Biborate of sodium,	44·18
Chloride of sodium,	45·30
Moisture,	7·80
Impurities (undetermined),	2·82
	100·00

Practically then, we have here a mixture of equal parts of borax and common salt and the "Regular" preservaline, which imparts to the meat a cherry-red color, as per announcement of the manufacturers and vendors of this article, is simply the same product, with the addition of some coloring matter or dye.

I was aware that the use of coloring matters was largely employed in certain articles of food, especially in all candies and cakes, and the like, but it was somewhat of a surprise to learn that enterprise in this direction had progressed so far as to impose dyed meat upon us.

I investigated the red sample for traces of arsenic, which possibly might be contained in the color, but I am glad to report that I found none.

The solution of both samples was strongly alkaline. Without any doubt, this product, on account of the large quantity of borax in its composition, will act as a good preservative, but it is unquestionably a fraud upon the public, so far as the selling price is concerned, as the following statement will show:

	Cents.
One pound of borax is worth	9
" " " salt " "	1½
Two " " mixed salt is worth	10½
One " " " " " "	5¼

It is put upon the market for the prices indicated in the following tabulation, reproduced from the manufacturer's circular:

"REGULAR."

For Curing Pork and Beef.	*Per Pound. Cents.*
In barrels,	14
100 lb. kegs,	15
50 lb. drums,	16
25 lb. drums,	16
10 lb. box,	16

Use one pound for every 100 pounds of meat.

This preservaline gives the meat a cherry-red color.

"A."

For Pork and Liver Sausage.

	Per Pound. Cents.
In barrels,	24
100 lb. kegs,	25
50 lb. drums,	26
25 lb. drums,	26
10 lb. box,	26

Sprinkle one-half pound over every 100 pounds of meat while being chopped or mixed.

"B."

For Bologna and Smoked Sausage.

	Per Pound. Cents.
In barrels,	16
100 lb. kegs,	17
50 lb. drums,	18
25 lb. drums,	18
10 lb. box,	19

Use one pound for every 100 pounds of meat.

Preservaline prevents any kind of sausage from turning sour, even in the warmest weather, and retains the natural color of the sausage.

Looking over the literature of the subject, I found that a series of investigations of similar products had been made by Mr. G. Polenski, (*vide Reports of the Imperial German Health Office*, 1889, No. 5, p. 364).

I quote therefrom the following data, respecting the composition of a number of such materials.

(1) THE REAL AUSTRALIAN MEAT PRESERVER.

(A nearly colorless liquid, emitting a strong odor of sulphurous acid.) It contains in one litre:

	Grams.
Calcium oxide,	11·08
Sulphurous acid,	46·03
Ferric oxide (alumina),	·039
Silicic acid,	·052

(2) REAL AMERICAN MEAT PRESERVER.

(The same liquid, but a stronger solution.) Contains per litre:

	Grams.
Calcium oxide,	26·42
Sulphurous acid,	89·60
Ferric oxide (alumina),	1·80
Silicic acid, and alkalies,	1·20

(3) CONSERVATIVE FOR SAUSAGES.

(The same liquid, slightly opaque, but odorless.) Contains per litre:

	Grams.
Saltpetre,	33·40
Boracic acid,	27·50
Glycerine,	50 00

(4) PRESERVING SALT OF R. LEISENTHAL, COLOGNE.

(Does not redden the meat.)

Borax,	48·40
Water of crystallization,	39·00
Common salt,	3·44
Sodium bicarbonate,	9·10

(5) PRESERVING SALT OF THE SAME MANUFACTURER (TO MAKE THE MEAT RED).

	Per Cent.
Boracic acid,	28·34
Common salt,	9·58
Saltpetre,	57·35
Water,	4·50

(6) PRESERVING SALT OF GAASE BROS., BERLIN.

	Per Cent.
Boracic acid,	29·70
Saltpetre,	37·80
Common salt,	26·70
Water,	5·80

(7) AMERICAN HAM PRESERVER.

(An acid, yellowish liquid, having an empyreumatic odor.) Contains per litre:

	Grams.
Potash alum,	70·
Saltpetre,	21·04

(8) STUTTGART CONSERVING LIQUID FOR MEAT.

(An acid liquid, having a strong sulphurous acid odor and a yellowish color.) Contains per litre:

	Grams.
Arsenious acid (As_2O_3),	0·103
Common salt,	5·500
Phosphate of lime ($Ca_3(PO_4)_2$,	41·940
Sesquioxide of iron and alumina,	0·440
Sulphurous acid,	37·440
Free phosphoric acid (H_3PO_4),	6·050

9. SIMPLE CONSERVING SALT, OF CONSERVING SALT CO., HAGEN.

(A white salt, in solution, alkaline.) Contains:

	Per Cent.
Borax,	21·95
Water of crystallization,	13·30
Saltpetre,	33·10
Common salt,	32·04

10. TRIPLE CONSERVING SALT OF THE SAME MANUFACTURER.

	Per Cent.
Salt,	0·80
Boracic acid,	55·50
Borax,	29·00
Water of crystallization,	14·70

11. SAZOLITH.

	Per Cent.
Sulphate of soda,	37·3
Sulphurous acid,	39·7
Soda,	21·0
Water,	2·00

12. BERLINIT.

	Per Cent.
Common salt,	7·5
Boracic acid,	9·
Borax,	82·7

BERLINIT PICKLE (for reddening the meat).

	Per Cent.
Salt,	45·9
Saltpetre,	32·2
Boracic acid,	19·2
Water,	2·0

13. CHINA PRESERVING POWDER. (MINERVA.)

	Per Cent.
Common salt,	25·00
Boracic acid,	17·7
Sulphate of sodium,	38·8
Sulphite of sodium,	9·2
Water,	9·3

14. AUSTRALIAN SALT.

	Per Cent.
Common salt,	5·5
Borax,	94·00
Hydrocarbon (?),	0·5

15. DR. C. RUEGER'S BARMENIT.

Equal parts of borax and common salt.

This last brings us home again. American ingenuity, it will be perceived, is again in the lead. All the liquids and powders here referred to are free from coloring matter. They all use saltpetre to impart the red color to the meat, but the inventor of preservaline introduces the novelty of a dye to take its place.

The directions given by the manufacturer for the use of the red "regular" for curing pork and beef, prescribe one pound for every 100 pounds of meat. This is equal to one-half per cent. of borax.

The prescription for the white, for curing bologna and smoked sausages, indicates the same quantity.

We have no positive knowledge of the action of large quantities of borax upon the human organism, when taken internally, though there can hardly be any doubt that if taken even in small doses continuously for a considerable time its effect must be hurtful. This question, however, I leave to the decision of others better qualified for passing judgment upon it than myself. It was simply my intention to call to your notice the common use of borax as a preservative for meat, and especially the misuse of anilin red to replace in such mixtures the use of saltpetre.

THE UTILIZATION OF THE BYE-PRODUCTS OF THE COKE INDUSTRY.

BY DR. BRUNO TERNE.

[*Read at the stated meeting of the Chemical Section, held Oct. 20, 1891.*]

About a year ago I had the honor to speak in the lecture course of the Franklin Institute on ammonia, its sources and technical uses.

I dwelt for reasons which I thought of sufficient importance, especially on the production of ammonia as a bye-product of the coke industry.

We have now entered upon the beneficial workings of the new policy of furthering industrial developments in new branches in a period which requires the technical men in all branches, and especially in the chemical industries, to call the attention of the capitalist to the points in which we are behind the times in our developments, to the points where the resources of our own land are neglected, and we are far behind the more progressive European manufacturers.

I thought it of sufficient importance to ventilate the same question before the Chemical Section of the Institute in order to create an interest in the circle of the members of the Institute, who are the best judges of such questions, in order to provoke criticism of my views.

I have revised the part of my lecture referring to the development of the ammonia industry for this purpose, not in the expectations of claiming new and original ideas, but to secure your attention to a point which I consider of great importance for the development of an important branch of the chemical industries.

We are surrounded by an immeasurable quantity of nitrogen gas in the atmospheric air.

The weight of the atmosphere surrounding our earth is calculated to be ten trillions of pounds, of which 7·77 trillions pounds are nitrogen; but in spite of this inexhaustible source of nitrogen, we are not able in a direct way to use a single pound for the production of ammonia.

It has long been the endeavor of the technical chemist to convert the nitrogen of the air into ammonia, but up to this hour none have succeeded in doing it with practical results. We are still compelled to use as sources for the production of ammonia, the products of plant or animal life.

The nitrogen of the air must pass through the channels of plant life to reach in the products of the animal body their highest degree of concentration.

Hoofs and horns with fifteen to sixteen per cent. dried blood, with nineteen per cent. hair and wool waste, with ten per cent. bones, with five per cent. of ammonia, are the richest sources.

But the products of animal life, however, even if they were not too valuable otherwise, are by no means sufficient to satisfy the wants of the present day for the products of ammonia. But Nature has provided an inexhaustible source for hundreds of years to come, in the residuum of plant life of former periods. In the bituminous coal fields and in the deposits of brown coal are lying stored up, billions of pounds of nitrogen waiting to be converted into ammonia.

The process of gaining this ammonia is incidental to the production of illuminating gas, to the production of coke, and to the production of animal charcoal.

In distilling the bituminous coal we obtain of the weight of coal used:

4–6 per cent. of tar and 6–10 per cent. of ammoniacal water of 1°·8 B.

As Prof. Lunge has shown, the nitrogen contained in the coal does not yield the amount of ammonia which we might expect:

Name of Coal.	*Yield of Nitrogen. Per Cent.*	*Possible Yield of Ammonia. Per Cent.*	*Possible Yield Ammonia Water. 1·020 spec. grav. Per Ton of Coal. Gallons.*
Wales,	0·71	1·10	142
Lancashire,	1·25	1·52	196
Newcastle,	1·32	1·60	206
Scotland,	1·44	1·75	226

But instead of these figures, the practical yield per ton of coal at the best is only forty-five gallons of gas water of 1·020 sp. gr., generally only twenty-five gallons, and in some instances, as low as thirteen gallons.

The ammoniacal liquors from distillation of animal refuse are much richer, but the small quantity produced allows us to ignore the same as a very insignificant factor in the production of ammonia salts.

The consumption of ammonia in its various forms has grown enormously in the last twenty years, and the manufacture of illuminating gas is no longer sufficient to supply the increasing demand for ammoniacal liquors. On the other hand the inroad which electrical plants for illumination have been making yearly on the production of illuminating gas, has already been felt, and will be more so from year to year. The production of water gas and oil gas are other factors which are cutting down the amount of ammoniacal waters produced.

But there is another source for tar and ammonia, which, so far as my knowledge goes, has, with a single exception, not been worked in our country.

Rich as are our resources, we are not rich enough to waste continually.

It seems strange, and nevertheless it is a fact, with all the ingenuity of the American people in the advancement of the purely mechanical part of the technical industries, we have been and are yet slow in the development of the chemical industries.

The acid manufacturer of Europe, especially of England

and Germany, had commenced in the beginning of this century to make himself independent of the sulphur mines of Sicily by using the sulphurous ores of his immediate neighborhood, and to utilize the pyrites for making his sulphuric acid. It has been only within the last twenty years that our people commenced to use the ores which had been lying under their feet, and to-day even, the United States consumes more sulphur for the manufacture of sulphuric acid than any other nation.

It is the same with productions of tar and ammonia as a bye-product of the manufactures of coke.

If you will visit our coal region to-day, you will find the nightly sky illumined from the fires of the coke ovens, and every one of the brilliant fires bears testimony that we are wasting the richness of our land in order to pay the wiser European coke manufacturer, who saves his ammonia an sends it to us in the form of sulphate of ammonia; and who also saves his tar, which, after passing through the complex processes of modern organic chemistry, reaches our shores in the form of aniline dyes, saccharin, nitrobenzol, etc.

As far back as 1768 tar had been produced as a bye-product of the coke industry by a chemical process at Fishbach, in the coal district of Soarbrücken on the Rhineland.

The general opinion of the consumer there was then, and most likely will be here at the present time, that the coke produced will be of inferior quality. Against this opinion of the practical coke men, it has always been held by technical chemists, that the process can be so conducted as to yield all the bye-product and still make a first-class coke.

Since about 1850, the producers of coke in France, Belgium, England and Germany commenced simultaneously the saving of the bye-products.

At St. Etienne, in France, a system of furnaces was at work in 1862 for which great success was claimed at that time. The gas and other volatile products of the coke oven were conducted to an air condenser, in which the tar and ammonia were condensed; the non-condensable gases were returned to the furnace as fuel.

Scrubbers and condensers have been improved to insure complete condensation.

The following average results have been claimed:

	Per Cent.
Coarse coke,	70
Small coke,	1½
Waste coke,	2½
Graphite,	½
Tars,	4
Ammonia water,	9
Gas,	10·58
Loss,	1·92

The net gain after deducting all expenses and without reckoning in the coke was, per oven, in Bessèges which has eighty-five ovens in operation, 111,446 francs. For eighty-five ovens this saving amounts to 94,690 francs or about $18,938.

I give you in the accompanying table, the results reported from two establishments in France.

I will not endeavor to cover the development of the coke industries of Europe for the whole period since 1850. I have had occasion to familiarize myself with all the conditions of this industry, and am in possession of figures and plans of Dr. Otto's successful ovens, a view of which I show you. (See accompanying plate.)

In 1883, a system of twenty ovens were built at the coke works of Gottesberg, Silesia, the results from which were so encouraging, that in the following year 120 ovens were built.

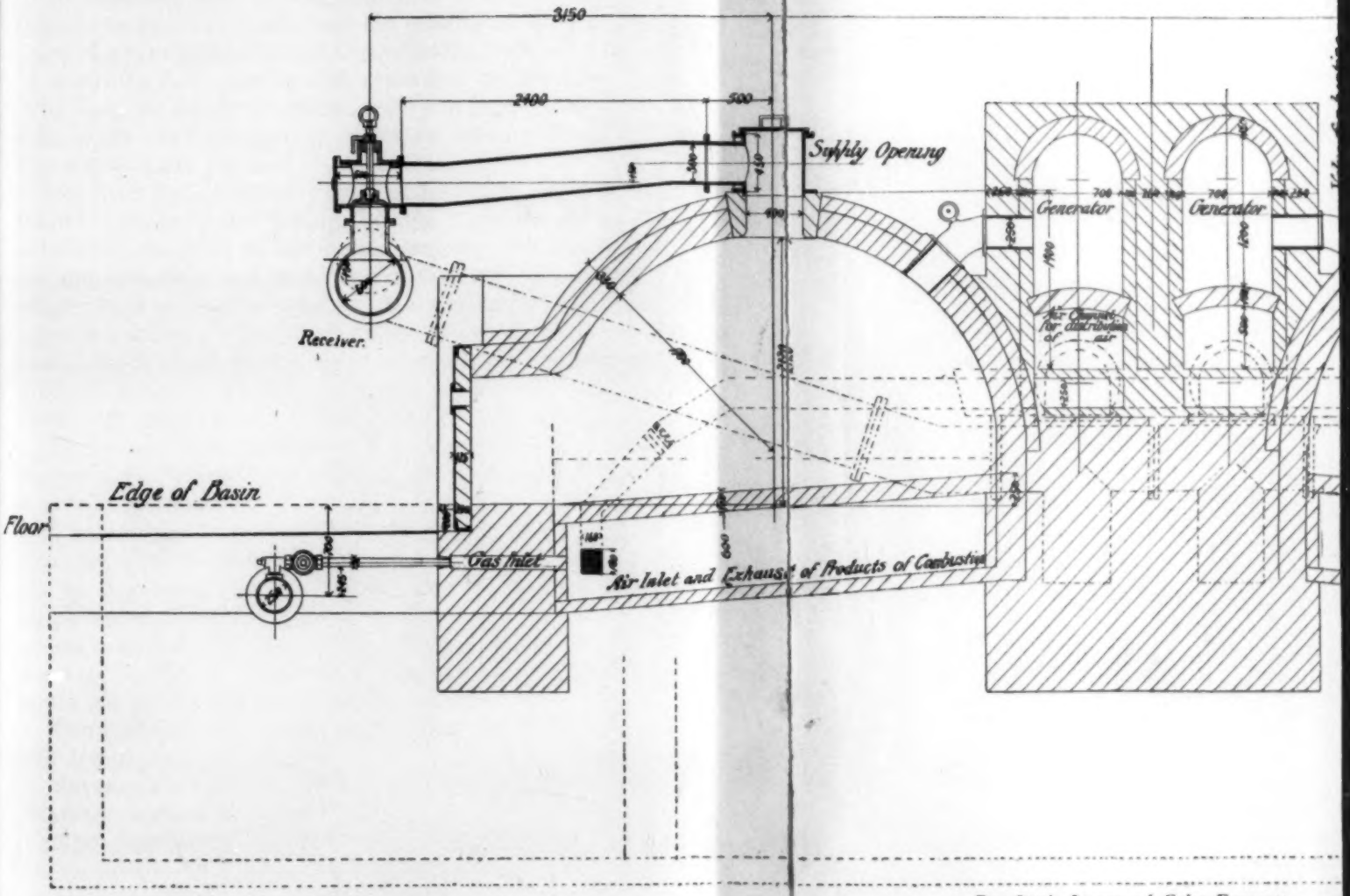
I will give you a report from a manufacturer, who, two summers ago, visited the Dahlhausen works of Dr. Otto, at the mines of Millensiven near Dortmund. Here, there are two sets of thirty ovens each, which are charged alternately every other day. The gases are conducted by large iron pipes to a large basin, where a part of the tar will be condensed. From there it is led to the coolers, where the remaining tar and ammoniacal products are absorbed, and the gas purified is returned to a gas holder, and from there is redistributed to the coke ovens, to the boiler fires and utilized as illuminating gas throughout the works. The gas returning to the coke ovens is mixed with hot air, and enters the flues

of the bottom and sides. The coke produced is an excellent product, and finds a ready market everywhere. It has not

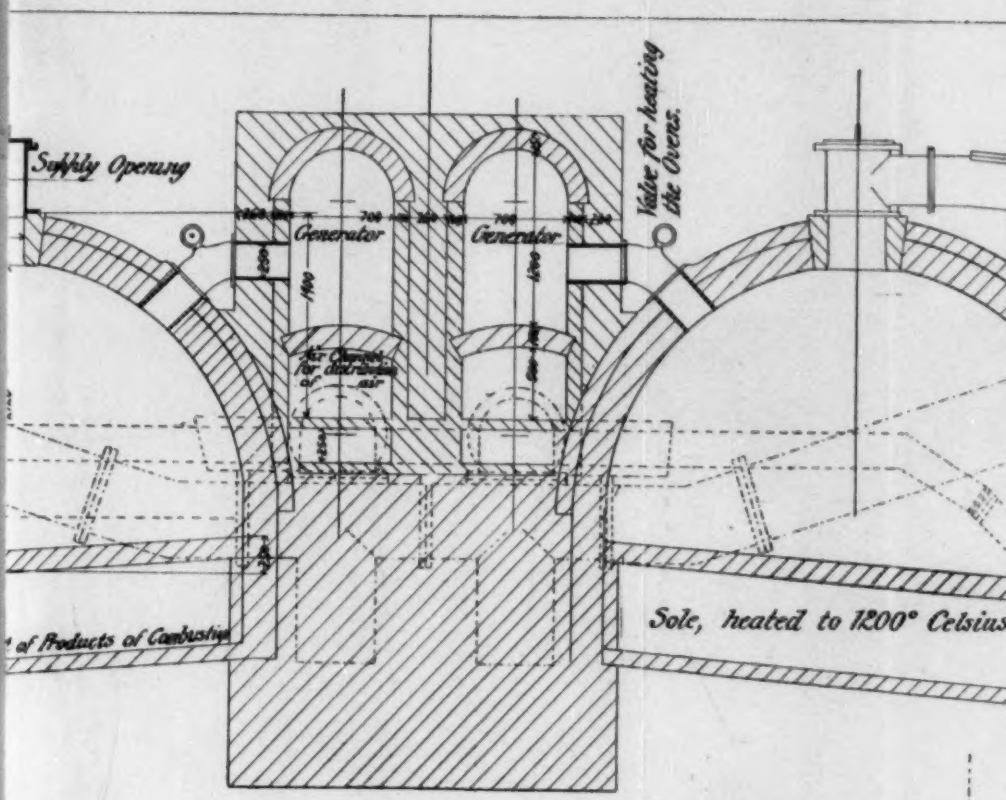
Name of Works.	Number of Ovens.	Tons of Coal Consumed.	Yield of Coke.			Tar.			Ammonia Water.		Sulphate of Ammonia.		
			Total Tons.	Prac. Per Cent.	Per Oven.	Total Tons.	Per Cent.	Per Oven.	Hectolitres.	Per cent.	Per Hectolitre. Kilograms.	Per Oven. Tons.	Per Ton of Coal Kilograms.
1879.													
Besèges, ...	85	46,908	33,092	70·55	389·3	1,096	2·33	12·89	44,932	9·6	6·5	3·435	6·22
Terrenoire, April 1 to December 31, 1879. . .	100	38,427	26,293	68·42	—	966	2·50	—	36,205	9·72	7·6	—	—
Per annum calculated, .	—	—	—	—	350·57	1,288	—	12·88	—	—	—	3·374	6·54

the silver gray or steel color of our Connellsville coke, but it is quite as good in quality as ours.

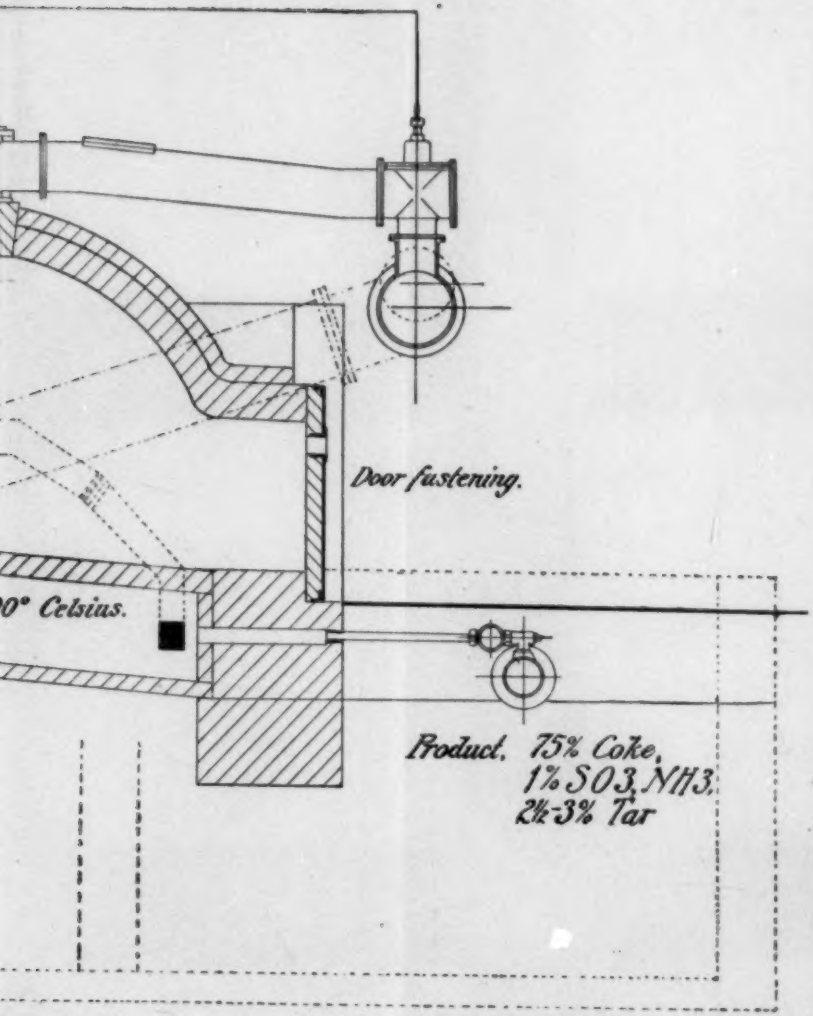
The person who pronounces this verdict was then, and

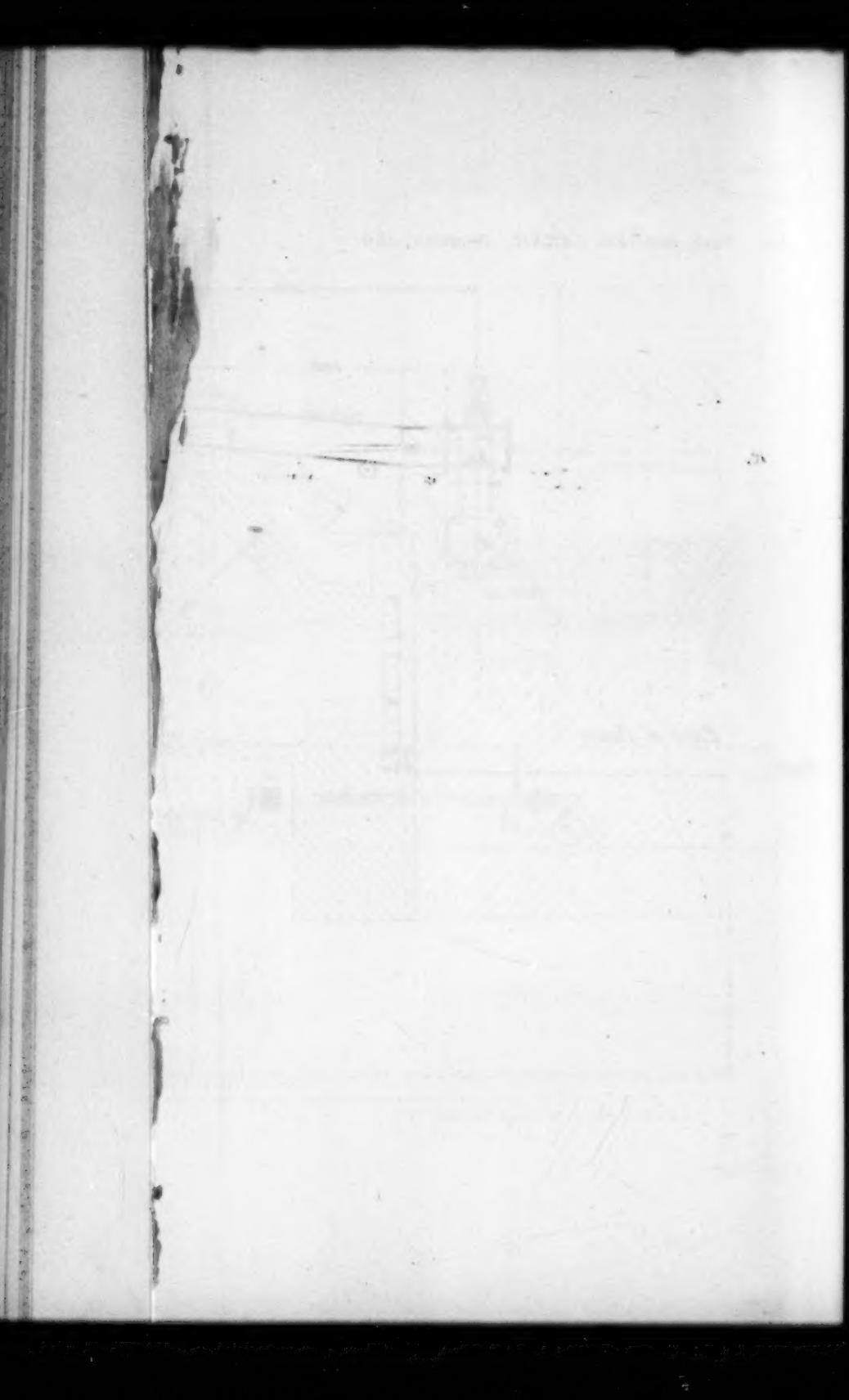


Dr. Otto's Improved Coke Furnace.



Dr. Otto's Improved Coke Furnace.


Door fastening.
0° Celsius.
Product. 75% Coke,
1% SO3, NH3.
2½-3% Tar



is now, connected with one of the largest iron works of our state, and thoroughly well informed upon every point of blast furnace produce, and familiar with the qualities of coke produced and used in the Connellsville region.

He repeated, after having explained to me how even the same color could be made, that the quality of this coke is in every respect equal to that of Connellsville. "But," he added, "I desire to call your special attention to the statement, 'The oven of Dr. Otto yields seventy to eighty per cent. of coke, while our Connellsville 'Beehive' oven will only yield fifty-five to sixty per cent.'"

D. Otto builds these ovens at his own expense, runs them for twelve years, taking the coal from the mines and delivering the coke to the mine company, for the yield of tar and ammonia, and at the end of the term surrenders the whole plant to the mine owners. He must make in this time from the value of the bye-products alone, the cost of the ovens, the interest of the capital invested and the legitimate profit of a manufacturer, and he is successful in doing it. Don't you think that we can achieve the same results here?

In the year 1887, there were in operation in 279 establishments in the United States, 26,001 ovens, and 3,594 ovens in course of erection.

These ovens consumed 11,859,753 tons of coal, producing 7,611,705 tons of coke, a percentage of 64·2. Calculated on the basis given in the table before you, the possible yield of sulphate of ammonia from this quantity of coal, *i. e.*, 12·8 pounds per ton, will give us the enormous figures of 151,804,838 pounds of sulphate of ammonia, which at three cents per pound only is equal to $4,554,746.

Pennsylvania is the principal coke-producing State in the Union.

Seventy-six and six-tenths of the coke used in the United States is made within her borders.

The number of establishments were, in 1887, 151, with 18,294 ovens, which produced 5,872,847 tons of coke, a yield of sixty-five per cent. The Connellsville district, of Pennsylvania, is one of the most important of the world. The Connellsville basin is in the southwestern part of the State,

some fifty or sixty miles from Pittsburgh. In this district were made 4,146,989 tons of coke, or 57·4 per cent. of all the coke made in the States.

At three works, during the year 1886, careful weighings were carried on, with the following results:

	Coal Charged.	*Coke Produced.*	*Per Cent. Yield.*
No. 1,	230,585	157,070,40	68,118
" 2,	60,934	40,947,09	67,188
" 3,	63,893·2	42,927,24	67·2
Total,	355,421·2	240,944,64	67·8

The coal used in Pennsylvania in 1887, for making coke, was 8,938,849 short tons.

If this had been done, with saving of the bye-products, 178,776 tons of tar and 114,417,267 pounds of sulphate of ammonia, or 7,208 $\frac{1267}{2000}$ tons of sulphate of ammonia could have been produced, which represents in ammonia salt alone a value of $3,432,480; or, to illustrate in another way, 28,604,316 pounds of ammonia, which has an agricultural valuation of eighteeen cents per pound, have been lost to the industrial and agricultural interests; or, at the valuation of the agricultural experimental stations, the loss of a single year was $5,128,776 $\frac{88}{100}$.

I am very well aware that these figures are imaginary, as under the best possible circumstances not all the coke ovens could readily be arranged for the saving of bye-products but if one-eighth or one-half of the total production were united with saving of the bye-products, from one to two millions a year on ammonia only could be produced in this State alone.

You will ask, Will the Connellsville coal give the same result as the German coal? Without hesitation, I answer, it will.

There are here five samples of coal from the Connellsville district, which have been analyzed in my laboratory, with the results given below:

	Per Cent.	
No. 1,	1·76	ammonia.
" 2,	1·26	"
" 3,	1·90	"
" 4,	1·80	"
" 5,	1·80	"

These analytical results place the coal of the Connellsville region on an even footing with the bituminous coal of the district, where the bye-products of coal are gained in making coke.

There are numerous systems of coke ovens in Europe, but none has been more successful than the ovens mentioned above. Whatever the system may be, the products of condensation must be separated; the tar from the ammoniacal waters, and each worked according to its specific requirements. In England, the escaping gases of blast furnaces have in two instances been worked for ammonia. I am unable, however, to say anything about results.

The interest of the manufacture of ammonia requires that the liquors should be as concentrated as possible, and still leaving the gases escape as free as possible from ammonia. To accomplish this, certain improvements in apparatus have come into use. The older construction of scrubbers, or apparatus for washing the gases, has been superseded by mechanical scrubbers. One of the latest constructions of such a scrubber is the one represented in the accompanying illustration. It is the form constructed by the Director of the City Gas Works, in Chemnitz, Saxony, and adopted by the best authorities of Germany as one of the most economical working forms of the apparatus.

The mechanical scrubber of E. Ledig* is based on the principle of the rapid absorption of ammonia by water distributed over a large surface, which is heated by a system of plates alternately dipping in water and raised out again, thus offering the gas the large surface of the combined plates. This up and down movement creates new surfaces for absorption with each motion, and secures a complete washing of the gas. The ammoniacal liquor so gained has now to be worked so as to gain the ammonia from it in order to prepare the different ammonia compounds.

The ammoniacal liquors contain free ammonia, carbonate of ammonia, sulphide of ammonium, sulphocyanide of ammonium, tartrate of ammonia, sulphite of ammonia, chlor-

* U. S. Patent, No. 407,937, July 30, 1889.

ide of ammonium, sulphate of ammonia, organic ammonia compounds, such as amin, pyridin, etc.

The ammonia waters contain in one litre, from coals of the

		Grammes.	
District	Zwickau (Saxony), ...	37.943	ammonium salts.
"	Ruhr (Rheinland).	29,402	
"	Saar "	43,225	
"	" "	9,506	

You will notice that the differences in yield are very wide, but nevertheless the smallest amount named is sufficient to make the gain, the bye-products, in the commercial scale, a profitable operation.

The oldest methods of gaining the ammonia were to saturate the liquors directly with sulphuric acid in large tanks. The cost of evaporating such enormous quantities of water and the impure condition of the product soon led to the invention of improved methods.

Tanks, or a system of tanks, were heated directly by fire or steam, and the volatile ammonia driven out to be absorbed by the acids in the receivers.

The newest improved forms of apparatus are those constructed by the well-known manufacturer of chemical products, Dr. Grüneberg, of Cologne, and by Dr. Feldmann, of Bremen. Both of these are constructed on the same principle, viz: a current of steam moves in opposition to the movement of the liquor. The richest liquor comes in contact with the nearly saturated vapors and the weakest liquor with the fresh steam.

These forms of apparatus have superseded in Europe, especially in England and Germany, the older devices.

The accompanying engraving (*Fig. 1*) shows the construction of the Grüneberg apparatus.

The apparatus of Dr. Feldmann is still simpler and is, therefore, preferred by a great many manufacturers of ammonia salts. (*Fig. 2.*) Both of these devices are patented in the United States.

The Feldmann apparatus cannot be excelled for economy of steam and reliability in service; its capacity for working five to twenty-five tons of liquor daily makes it likewise

desirable for a rural gas works as well as large establishments.

The question Will it pay to gain the bye-products of the manufacture of coke? has been practically solved in the affirmative. The numerous objections have, step by step, been overcome. The industry of the coke production com-

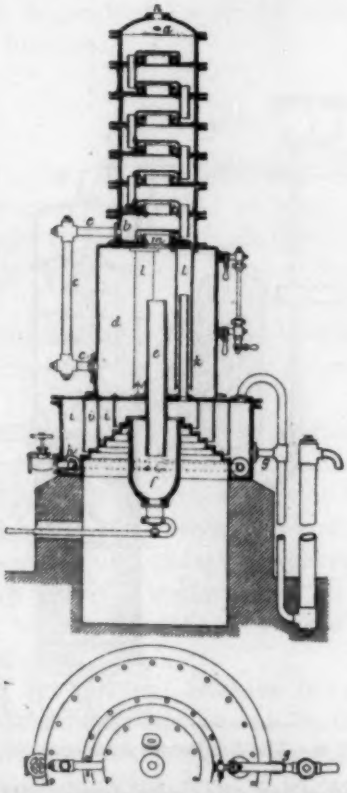


FIG. 1.—The Grüneberg Ammonia Still.

bined with the saving of the bye-products is an established fact in Europe, and will be here also in the near future. What system of ovens will be found best adapted to our wants, may be an open question to decide, which rightly will require the consideration of a great many points of local importance.

The system which I have described is one of the most successful of those used in Germany to-day.*

I advocate the Otto system because I know of its merits and advantages from a careful study of it, and lengthy correspondence with the inventor.

The results obtained by Dr. Otto, Copper and others, exhibit such decided progress over the past, that it is only

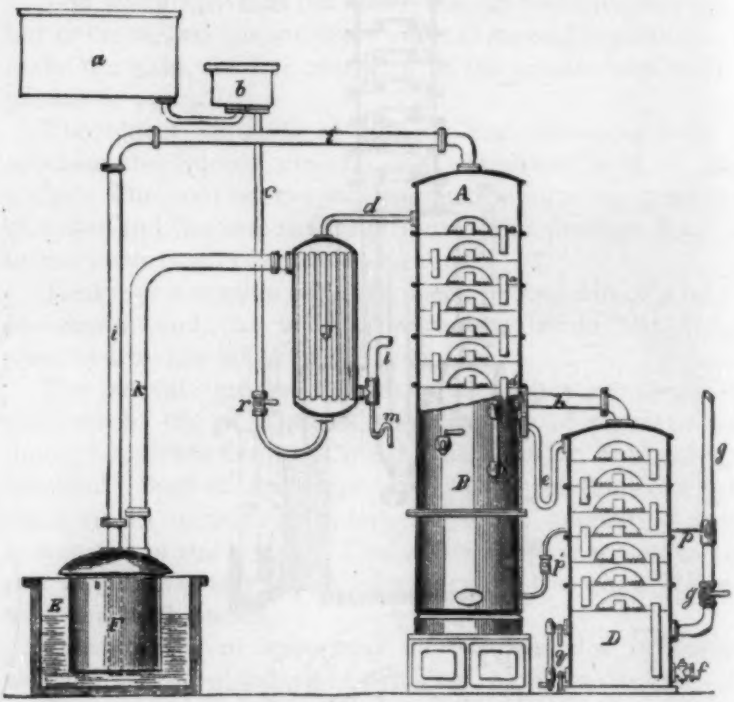


FIG. 2.—The Feldmann Ammonia Still.

a question of time when the coke producers of the United States must fall in line.

The advance in the coke industry will cause an advance in the tar color industry, and will further the growth of the soda industry based on the ammonia process.

---

* The latest improvements are covered by D. R. P. 52,206, Universal coke-oven, C. Otto and F. W. Larmann.

If I have succeeded in adequately exhibiting the importance of saving the valuable products at present wasted in our coke industries, I shall have accomplished my purpose.

Until every pound of ammonia used in our land is produced in our land, until every pound of soda is made from our own salt wells by the ammonia process, we will continue to be dependent upon the chemical markets of Liverpool and London.

DISCUSSION.

Dr. H. W. JAYNE: No one will deny the importance of the subject presented to us this evening by Dr. Terne, and I am aware that it has been carefully investigated by a number of large firms in the country, but as yet nothing has been done.

Coke operators fear that it would be difficult to overcome the prejudice against the coke as it has not the silvery appearance of the Connellsville article.

The great first cost of the plant is another serious obstacle. An ordinary beehive oven to work about 480 tons per year costs about $280, while a Carves oven of the same capacity costs complete with the coolers and all appliances $845 each, and Otto ovens of 1,000 tons capacity would cost $750 for ovens, and $1,450 for coolers and all other machinery and buildings. The above figures were furnished by the respective inventors.

In addition, the present beehive oven is of extremely simple construction, and can be run by the most unskilled labor, while the improved ovens are complicated and require nice working and constant repairs to prevent loss of gas, and consequent loss of the bye-products.

There can be no doubt that eventually such ovens will be introduced, and when in successful operation, other coke producers will be compelled to erect them, as they could not possibly stand the competition caused by ovens producing not only such valuable bye-products, but also such a greatly increased yield of coke.

Dr. TERNE said: I would like to state, that according to Dr. Otto's figures in my hand, the cost per oven, without condensation apparatus, is 1,508 marks ($377.) Or, for a battery of thirty-eight ovens, with complete condensation apparatus:

(I) 38 ovens,	57,304	marks.
Condensation apparatus,	117,683	"
	174,987	"
Equal to,	$43,746	75
Or, per oven,	1,151	20

It is well to state here that the apparatus of condensation for the winning of the bye-products will outlast the life of the ovens many times; the first cost will, therefore, be limited to the first system erected.

Mr. HENRY BOWER referred to a short article which he had recently seen in the *Chemical Trades Journal* of Manchester, England, in which it was stated that it was not certain whether certain firms of speculators were not contributing to the depression in the prices of anthracene and benzole in the hope of frightening investors from opening additional carbonizing works. Mr. Bower also referred to the depression existing in the prices of sulphate of ammonia, and the influence of tar-producing concerns in Philadelphia against the carbonizing process.

Dr. JAYNE: The statement, referred to by Mr. Bower, which appeared in the *Chemical Trades Journal*, of Manchester, referred to the fact that the large production of benzole by the coke carbonizers prevented the extreme prices which would otherwise prevail owing to the great consumption of this article at present, especially in the preparation of medicinal articles.

Before the carbonizing plants were in operation benzole fluctuated very violently, ranging from thirty cents to $1.25 per gallon in one year.

The large amount of benzole produced by the coke plants is not obtained from the tar, which contains only a small quantity, but from the gases, which contain about twenty-five times as much as the tar.

In our cities it is impossible to remove this benzole from the gas, as it would at the same time remove most of the illuminating properties, but the coke gases can be cooled and washed with oils removing most of the benzole.

The inventors of the Simon-Carves oven claim that they can thus obtain three-fourths of a gallon of a high grade benzole from one ton of coal. It may be interesting to note in this connection that there are, or were, several plants running in England carbonizing coal in gas retorts entirely for the bye-products, as such coke is of little value. One of these works at the "Talk of the Hill" Collieries had 300 retorts in use producing 12,000 gallons of benzole per month.

Dr. TERNE: In reply to the remarks of Mr. H. Bower, I beg to say that the influence of the tar-producing companies of Philadelphia will not be dominant enough to prevent the development of this branch of chemical industries.

The combined interest of the larger producers and consumers of tar and ammonia will finally regulate the development of this industry.

To the further remarks of Mr. H. Bower, I should answer that I desire it distinctly to be understood that I do not advocate the producing of coke only for the gain of ammonia.

The higher yield of coke, the gain of the tar, with the daily increasing demand for same, and the gain of the ammoniacal water are the inducements which are given by the new methods.

The temporary depression in the price of sulphate of ammonia will not last, and even yet at ruling low prices we have not reached two and one-half cents per pound as on the other side.

We do not need to be frightened by wages; it will cost very little more to make coke and gain the bye-products than it now costs, and the slight additional cost will be amply repaid by the tar and ammoniacal water.

The cost of sulphuric acid does hardly come in play, first because we get a higher price for sulphate of ammonia produced, and second, we do not need to turn the ammonia in sulphate.

The ammonia soda industry of this country is in its infancy, and the demand of concentrated ammoniacal waters for the same will be steadily increasing.

The development of these industries is bound to come in spite of all objections, and it will be not so far off either. The right start is the most difficult point.

PROCEEDINGS

OF THE

ELECTRICAL SECTION

OF THE

FRANKLIN INSTITUTE.

[*Proceedings of the stated meeting, held Tuesday, October 6, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, October 6, 1891.

Prof. EDWIN J. HOUSTON, President, in the chair.

Present, twenty-one members and visitors.

The minutes of the previous meeting were read and approved.

One nomination to membership was referred to the Committee on Admissions. The committee reported six elections since last meeting.

It was moved and carried that the President appoint a committee of three members to secure papers for the meetings.

Mr. H. W. Bartol was unable to present his paper on "The Electric Railway of Buda-Pesth," not having received the expected data with regard to it.

Prof. Edwin J. Houston described the probable production of electricity from light in the leaves of plants, and promised a more formal presentation of the subject later. In the discussion that followed, the analogous action in the selenium cell and applications of it were described.

The Question-box contained queries on the advantages and disadvantages of slow speed in motors, the practical working of the Evans frictional method of driving, the latest theory with regard to the earth's magnetism, and the practicability of dispensing with earth connection for lightning rods—all of which were discussed at some length.

The Chair appointed on the Committee to secure Papers, Dr. Wahl (Chairman), Messrs. Carl Hering and Pike.

The meeting then adjourned.

L. F. RONDINELLA, *Secretary.*

CORRESPONDENCE.

THE PATH OF A PROJECTILE.

To the Committee on Publications.

GENTLEMEN:—The formulæ deduced by Mr. Gilman, in the *Journal* for October, relative to the path of a projectile on the hypothesis of a resistance varying directly as the velocity, may also be found (or their equivalents) in Captain Ingalls' *Exterior Ballistics in the Plane of Fire*, a text-book used at the artillery school, Fort Monroe, and published by Van Nostrand, in 1866. It is believed that the applications of these simple and analytically exact formulæ to modern gunnery are there given for the first time. The author of this text-book gives a table of the values of Mr. Gilman's "c" (or rather

$$\frac{d^2}{cw}$$

d being the diameter, and w the weight of the projectile) for the muzzle velocities commonly employed in mortar practice, deduced in a novel manner from Bashforth's experiments, at Shoeburyness, England. He applies these formulæ, in connection with the table, to the computation of the ranges and times of flight of mortar shells fired with angles of projection varying from 30° to 60°, and compares the computed ranges with those observed at the Krupp proving ground, Meppen, and finds an average discrepancy between computation and experiment, of considerably less than one per cent.

Captain Ingalls' formulæ (which are equivalent to those deduced by Mr. Gilman) give the time of flight and horizontal range between two given points, as functions of the horizontal velocities at those points.

If one of the points is the "point of projection," and if we write

$$U = V \cos \alpha$$

$$u = v \cos \theta$$

we have for the time of flight and horizontal projection of the trajectory, the simple equations

$$t = \frac{1}{c} \log \left(\frac{U}{u} \right)$$

$$x = \frac{1}{c} (U - u)$$

Eliminating u from these equations gives Mr. Gilman's equation (5). For the equation to the trajectory we have

$$y = \left(\frac{g}{c\,U} + \tan \alpha \right) x - \frac{g\,t}{c}$$

or, substituting for t its value in terms of x, gives Mr. Gilman's equation (7).

For the relation between the horizontal velocities and the inclinations of the tangents at two points of the trajectory we have

$$tan\ a - tan\ \theta = \frac{g}{c}\left(\frac{1}{u} - \frac{1}{U}\right)$$

Combining this with the expression for x gives

$$x = \frac{U\,u}{g}\,(tan\ a - tan\ \theta),$$

while the corresponding expression for x *in vacuo* is

$$x = \frac{U^2}{g}(tan\ a - tan\ \theta).$$

It follows from these last two equations that if U, a and θ are the same in both trajectories, their horizontal projections between the two given points, or points of equal inclination, are proportional to the horizontal velocities at those points.

JAS. M. INGALLS,
Capt. 1st Art'y.

Fortress Monroe, October 13, 1891.

THE STEAMLOOP.

To the Committee on Publications.

GENTLEMEN:—I was pleased to note, in the October *Journal*, a very able article by Mr. Walter C. Kerr, on the "Steamloop." While the literature on this minor subject is perhaps not as full as might be expected, still the subject itself has been quite thoroughly exploited in a practical manner many years ago. The first time this subject was called to my attention was, I think, in 1873, by a salesman, who was selling a so-called "steam trap," the manufactory thereof being located somewhere in central New York; the exact location I do not now recall, nor the name of the concern. However, the firm in whose employ I then was purchased three of these traps. The trap consisted of a ribbed globe about ten or twelve inches in diameter, which acted as a condenser. On top of this globe was an air valve and also a branch pipe, leading to a vessel corresponding to the device now called a "separator." The globe was elevated about ten to fifteen feet above the boiler, and the bottom of the same connected with the boiler below the water line with a check-valve, etc. There was also a check-valve near the condenser globe in the pipe leading from the separator. The first of these three devices was set up and put into operation by me in Hudson, Wis., for the West Wisconsin Railroad, either in 1873 or 1874, and worked very perfectly and completely through about 350 feet of line, the separator being perhaps eight to twelve feet below the water-line of the boiler. Its initial operation was so satisfactory that two more were ordered, one for the State's Prison in Stillwater, and one for the State House in St. Paul. However, a more extended use of the first appliance in connection with a heating apparatus of considerable magnitude, developed the facts Mr. Kerr refers to; that is, the liability of "flooding" to such an extent that all three of the devices were

subsequently abandoned, and other devices substituted therefor. At various times during the past sixteen years, I have used this device for a single radiator or single heating device, with very satisfactory results. In 1875, I put the device on a brewer's kettle, in St. Paul, but its operation was not very satisfactory, and more so, perhaps, through the prejudice of the brewer than for any inherent defects in the device itself. I do not know who the original discoverer of the device was, but I believe it to have been Mr. James H. Blessing, of Albany, N. Y. However, my experience with its use has been that it was more satisfactory on the steam pipe leading to an automatic engine than in any other place, owing to the effect produced by the momentum of the current of steam in the pipe, when the induction valves of the engine closed.

As a matter of curiosity, if any one knows, I would like to know who was the original discoverer of this method of handling the water of condensation, primage and entrainment, and where it was first used.

Respectfully yours,

E. F. OSBORNE.

Chicago, October 5, 1891.

BOOKS RECEIVED.

[In sending books for notice in the *Journal*, publishers are requested, for the information of the reader, as well as for their own advantage, to give the price. This announcement by title will be followed, in most cases, by a review, which will appear at the earliest opportunity.]

Manual of the Steam Engine for Engineers and Technical Schools. Part 1. Structure and Theory by Rob't H. Thurston. New York: John Wiley & Sons. 1891. 8vo, pp. 871. Price, $7.50.

Guides for Science Teaching. No. 8. Insecta. By Alpheus Hyatt and J. M. Arms. Boston: D. C. Heath & Co. 1890. 12mo, pp. 300. Price, $1.

WOODBRIDGE SCHOOL ESSAYS. No. 1. *Theoretical Astronomy. Dynamics of the Sun.* By J. Woodbridge Davis. New York: Woodbridge School. 1891. 4to, pp. 97.

Zodiacal Light. By M. A. Veeder. Rochester: Academy of Science. 1891. 8vo, pp. 10.

Elektrotechnische Bibliothek. Band 43. Die Elektrischen Verbrauchsmesser. Von Etienne de Fodor. Wien: A. Hartleben. 1891. 12mo, pp. 219. Price, 75 cents.

Plane and Solid Geometry. By Seth T. Stewart. New York: American Book Company. 1891. 12mo, pp. 406. Price, $1.12.

Théories Modernes de l'Électricité. Essai d'une théorie nouvelle by O. Lodge. Traduit de l'Anglais et annoté. Par E. Meylan. Paris: Gauthier-Villars. 1891. 8vo, pp. 216. Price, $1.25.

Transition—Curve Field-Book. By Conway R. Howard. New York: John Wiley & Sons. 1891. 12mo, pp. 109. Price, $1.50.

Maximum Stresses under Concentrated Loads treated Graphically. By Henry T. Eddy. New York: D. Van Nostrand Company. 1890. 8vo, pp. 100.

Traité d'Électricité et de Magnetisme. Par A. Vaschy. Paris: Baudry et Cie. 1890. 2 vols. 8vo. Price, $5.

Appleton's School Physics. By John D. Quackenbos, Alfred M. Mayer, Francis E. Nipher, Silas W. Holman, Francis B. Crocker. New York: American Book Company. 1891. 12mo, pp. 544. Price, $1.20.

Theory of the Continuous Girder. By Malverd A. Howe. New York: Engineering News Publishing Company. 1889. 8vo, pp. 119.

Principles of Agriculture for Common Schools. By I. O. Winslow. New York: American Book Company. 1891. 12mo, pp. 152. Price, 60 cents.

Patent Franchise of the United States. By G. H. Knight. New York: 1891. 8vo, pp. 24.

Short Manual of Analytical Chemistry. Qualitative and quantitative—inorganic and organic. By John Muter. First American from the fourth English edition. Edited by Claude C. Hamilton. Philadelphia: P. Blakiston, Son & Co. 1891. 8vo, pp. 206. Price, $2.

Irrigation Statistics of the Territory of Utah. Compiled and prepared for the Irrigation Congress. By Chas. L. Stevenson. Salt Lake City. 1891. 8vo, pp. 36.

Nu English. A proposed simplified language for home use and for International commerce and travel. By Elias Malee. Minneapolis: Author. 1890. Pp. 32. Price, 25 cents.

John Wiley & Sons announce, as in preparation, *A Manual of Mining.* By Prof. M. C. Thesing, Golden, Col.

BOOK NOTICES.

A Hand-Book of Industrial Organic Chemistry. Adapted for the Use of Manufacturers, Chemists, and all Interested in the Utilization of Organic Materials in the Industrial Arts. By Samuel P. Sadtler, Ph.D. Philadelphia: J. B. Lippincott Company. 1890.

This large octavo, of 519 pages, is the first of its kind to appear in America, and if we except one or two antiquated translations, it is the only single volume on applied chemistry in the English language. The whole is divided into fourteen chapters as follows:

I. Petroleum and Mineral Oil Industry.
II. Industry of the Fats and Fatty Oils.
III. Industry of the Essential Oils and Resins.
IV. The Cane Sugar Industry.
V. The Industries of Starch and its Alteration Products.
VI. Fermentation Industries.
VII. Milk Industries.

VIII. Vegetable Textile Fibres.
XI. Textile Fibres of Animal Origin.
X. Animal Tissues and their Products.
XI. Industries Based upon Destructive Distillation.
XII. The Artificial Coloring Matters.
XIII. Natural Dye Colors.
XIV. Bleaching, Dyeing and Textile Printing.

Some of these include more than would at first appear, for instance, Chapter X treats of the leather industry as well as those of gelatin and glue, and Chapter VI of wine-making, the manufacture of distilled liquors, bread-making and the manufacture of vinegar.

Each chapter or subdivision is systematically arranged into:

(1) Raw Materials.
(2) Process of Treatment.
(3) Products.
(4) Analytical Tests and Methods.
(5) Bibliography and Statistics.

This plan of treatment has enabled the author to present the subject compactly, and it also admits of being readily grasped by the reader.

The bibliography forms an important part of each subject as it should in all works of this character. The same might be said of the statistics; and both when brought closely up to date, as in the present work, are of the greatest value to the manufacturer.

There are 127 illustrations and fourteen diagrams distributed through the volume, which assist the descriptions and add to the value of the work. An Appendix of over twenty pages embraces the metric system, tables for the determination of temperatures, specific gravity tables and alcohol tables.

It is evident the author has not made a mere compilation, but that he has drawn largely from his own experience as teacher and expert, the latter capacity having given him opportunities to study many processes where they are conducted on a commercial scale. Where he has not had all the desired experience in certain technical work he has availed himself of the assistance of others in these special subjects; this is particularly the case in Chapter XIV.

That the French and Germans are so well supplied with such books, while we hitherto have had none is remarkable and difficult to explain, unless we attribute it to the disposition of the American manufacturer to invent and keep secret his own processes.

The author, no doubt, felt the need of a work both in his teaching and practice, that would not only describe the various organic technical processes, but also bear more directly on those chemical industries which are peculiar to this country, descriptions of which are, therefore, not to be found in foreign books. In supplying this demand he has prepared a volume that will be appreciated by other chemists, as well as by those who wish quickly to gain a knowledge of special processes, as is frequently the case with attorneys and others interested in patent suits.

The book is written in a clear, interesting style that will make it attractive to the general scientific reader as well as to the specialist.

Perhaps the only suggestion that can be made is that some of the chapters might have been lengthened with advantage; and it is to be hoped that in each succeeding edition it will be enlarged with the results of the author's investigations on the various chemical industries. T.

The Mechanical Engineers' Reference Book for Machine and Boiler Construction. By Nelson Foley and Thomas Pray, Jr. In two parts. Part 1: General Engineering Data. Part 2: Boiler Construction. New York: D. Van Nostrand Co. 1891. Fo. pp. 6 and 148. Draw. 19. Diag. 30.

As a general thing, engineering books of reference have been made as nearly in pocket form as was possible. Where such a form was not feasible by reason of the size of type used, the octavo volumes were about the best for desk use, but now there comes to us a volume measuring 15½ x 12 inches, under the title of *The Mechanical Engineers' Reference Book for Machine and Boiler Construction*, by Nelson Foley, member of the Institution of Naval Architects, of the Institution of Mechanical Engineers, and the Northeast Coast Institution of Engineers and Shipbuilders, assisted by Thomas Pray, Jr., Consulting and Constructing Engineer for Steamships, Locomotive Engines, Stationary Engines and other Machinery; member of American Society of Naval Engineers and various other societies, having residence in Boston, Mass., while Mr. Foley at present is living in Italy.

The book comes from the press of D. Van Nostrand Co., and is printed on good paper in very good type, and has the advantage of what is known as the "ledger index," or notched index on the margin, being in this case what is termed in the trade a "reinforced ledger index," each of the marginal projections that enable the book to be opened at any particular place, being strengthened by muslin as well as paper, the paper being in different colors, beginning with white and running through blue, red and green, separated by others of white.

Upon the margin of the book can be seen at a glance, first: "Measures," then in the next set of pages: "Decimal Equivalents," "Speed Tables," "Thermometers," "Angles," "Surface of Reciprocals," "Logs," "Mensuration," etc., "Sheets per Square Foot," "Sheets and Bars," "Miscellaneous," "Work and Power," "Heat," "Combustion," "Expansion," "Steam," "Statics," "Dynamics," "Electricity," "Strength of Materials," "Elasticity," "Friction," "Flow of Liquids and Gases," "Miscellaneous." In Part 2: "Boilers," "Rules for Scantlings," "Riveting," "Miscellaneous," "Diagrams," "Shells," "Furnaces," "Flat Plates," "Tube Plates," "Girders," "Riveting," "Rivet Length," "Coal," "Drawings."

In addition some slips show merely small wood-cuts, to indicate the subject as two spur gear wheels, two pulleys united by a belt, a small steamship, a turning tool in the act of taking a chip, a pair of scales, and so on.

The book contains 150 pages, besides a large number of drawings and diagrams to scale, enabling one to judge of proportions by a glance at such scales, and giving the advantage of the graphical method of computation.

The author has aimed to simplify and to put into available shape, for instant reference all the most needed matter applicable to ship and engine building up to the present time, and to include the newest engineering data, from practice. The confusion of units applicable to the same requirements has had attention, and an attempt has been made to simplify, as far as possible, what have been considered illy-expressed formulæ, falling back on Rankine in its entirety for his formulæ as far as they would go, and to Regnault for his, omitting a mass of extraneous matter, doing away with confusion from imperfect and careless as well as varying copying.

The graphic computation is understood to be Mr. Foley's, who has been highly commended for his execution of this work by all those who have had an opportunity to use it.

The tables and the graphical part determined the size of the book, and other requirements had to bend to this.

The work on engines, boiler, screw and compound working of steam formulæ has been much modified and brought up to date, at the same time being simplified so far as possible.

It represents a work produced with the editor in Italy, the publisher in London and the assistant editor in the United States; a happy illustration of modern facilities for correspondence.

A careful examination of the pages of this work cannot fail to impress the observer with its utility, and the ready means of reference by the index is particularly convenient. The price of the book is one that will put it beyond the means of some individuals who could use it to advantage, but at the same time it is one of those books that should be in the drawing-room of every machine shop, accessible to the draughtsman and convenient for reference.

Apart from much that is accepted in the literature of mechanics as classical, there are many pages showing the individuality of the author, and much in this respect that is new, while it is all useful.

Since publication a few errors have been discovered as follows:

Page 12, 8″ column at top, change ft. 62 to ft. 62°.

" 53, top right hand, for foot pounds × 7·233 read foot lbs. × ·138.

" 53, top right hand, kilogrammetres × ·138 read kilo. × 7·233.

" 60, near foot reference to page 39, read to page 41.

" 60, next to last example, read 60,081 lbs. not cubic ft.

" 61, near foot reference to pages 52 and 40 should read 54 and 42.

" 92, about one-fourth way down for page 84 read page 83.

" 94, about one-fifth way down for page 84 read 83.

" 115, near top for $V = 5535 \sqrt{\frac{P^{1\cdot8} \times P^{\cdot1} - P_1^{1\cdot9}}{P^{1\cdot841}}}$

read $V = 5535 \sqrt{\frac{P_1^{1\cdot8} \times P^{1} - P_1^{1\cdot9}}{P^{1\cdot841}}}$

Repeated reference to this book during the summer has, on the whole, been satisfactory and useful. It is certainly a valuable addition to the works

of reference in the library of the Franklin Institute, and cannot fail to be appreciated by those members who choose to avail themselves of its excellently arranged matter. C. S.

Calkin's Steam Engine Indicator, New York. The Engineers' Instrument Company. 1891. Pp. 114.

The work is a description of the special forms of apparatus manufactured by this company. The indicator itself differs from those heretofore in common use, in many minor details. The parallel motion is obtained by slotting the top of the piston rod in such a way that the pencil moves proportionally to the movement of the piston. The indicator spring is a single one, and to prevent its tipping and the piston bearing cornerwise on the sides of the cylinder "peculiar manipulation takes place during its manufacture." The method of applying and taking care of the instrument is carefully set forth, and numerous tables and methods of calculation are given, applying equally to all indicator cards, which would aid the user in obtaining all the results desired for the indicator card. The other instruments treated of are the graduated pantograph, polar planimeter, parallel rule, dividing scale, speed indicator, and Calkin's mercurial column for testing gauges, etc.

H. W. S.

PROGRAMME OF LECTURES.

(Season 1891–1892.)

1891.

November 2. Mr. Henry Pettit, "Down the Takaio in Japan" (illustrated by photographs taken by himself).

6. Mr. C. J. Hexamer, "Italy, I" (illustrated).

9. Mr. Henry Pettit, "How the Chinese Differ from Ourselves" (illustrated by photographs taken by himself).

13. Mr. C. J. Hexamer, "Italy, II" (illustrated).

16. Mr. Courtney De Kalb, Mining Engineer, New York, "The Great Amazon: Personal Investigations on the River and its Upper Valley."

20. Prof. Lewis M. Haupt, University of Pennsylvania, "The Port of Philadelphia."

23. Mr. Louis Vossion, Consul of France, "The Khartoum of Gordon's Mission" (illustrated by photographs taken by himself).

27. Mr. Eugene Griffin, Boston, "The Electric Transmission of Power."

30. Prof. J. Howard Gore, Columbian University, Washington, D. C., "How the Earth is Measured."

December 4. Mr. Carl Hering, Electrical Engineer, "Notes on the Frankfort Electrical Exhibition"

December. 7. J. Madison Taylor, M.D., "Physical Exercise: its Relation to Health and Medicine."

11. Mr. William L. Saunders, C.E., New York, "The Compressed Air Power of the Future."

14. Mr. William Kent, Mechanical Engineer, New York, "Some of the Preventable Wastes of Heat in the Generation of Steam."

18. Mr. F. E. Ives and Mr. W. N. Jennings, "The Yellowstone Park" (illustrated with color camera and kodak).

25. Prof. Persifor Frazer, D. Sc., "Christmas Lecture for the Children." 3 o'clock P. M.

1892.

January 4. Prof. Chas. E. Munroe, U. S. Torpedo Station, Newport, R. I., "Transmission of Explosive Phenomena."

8. Hon. Warner Miller, New York, "The Nicaragua Canal."

11. Prof. Wm. C. Day, Swarthmore College, "The Building Stones of the United States."

15. Mr. Alfred E. Hunt, C.E., President Pittsburgh Reduction Company, "Aluminum from an Engineering Standpoint."

18. Prof. G. C. Caldwell, Cornell University, "Oleomargarine."

22. Mr. W. F. Durfee, Mechanical Engineer, "Historical and Constructive Curiosities of Ancient and Modern Mechanism."

25. Prof. S. P. Sadtler, Ph.D., "The Chemistry and Technology of Starch."

29. Dr. L. Webster Fox, "Eyesight: its Care during Adult and Old Age."

February 1. Prof. S. P. Sadtler, Ph.D., "Cellulose, or Wood Fibre."

5. Mr. Edward E. Allen, Principal Pennsylvania Institution for the Instruction of the Blind, "Mechanical Education of the Blind."

8. Mr. H. M. Howe, Mining Engineer, Boston, "Manganese Steel."

February 12. Mr. E. Berliner, Washington, D. C., "Technical Notes on the Gramophone."

15. Mr. Nikola Tesla, New York, "An Experimental Study of Light Effects produced by Alternating High Potentials."

19. Mr. John Hartman, "Notes on the Blast Furnace."

22. Public Holiday; no Lecture.

26. Prof. D. S. Jacobus, Stevens Institute of Technology, "Experimental Illustrations of the Principles and Properties of Substances applied in Modern Refrigerating Machines."

29. Prof. Edward Orton, Director of the Geological Survey of Ohio, "Petroleum: its Geological History and Use in Modern Civilization."

Franklin Institute.

[*Proceedings of the stated meeting, held Wednesday, Oct. 21, 1891.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, October 21, 1891.

Mr. JOS. M. WILSON, President, in the chair.

Present, 126 members and sixteen visitors.

Additions to membership since last report, twenty-four.

The Secretary presented a memorial of the late Mr. Louis H. Spellier, which was accepted and referred to the Committee on Publications.

Mr. C. M. Lungren, of New York, read a paper descriptive of a new incandescent gas light of his invention, illustrating the same by showing a number of the lights in operation. The light is produced by the incandescence of a thimble-shaped burner, about two inches high and one and one-half inches in diameter at the bottom, formed of interlaced or woven threads composed of the rare earths, thoria, zinconia, etc. These threads have a thickness of about $\frac{14}{100}$ of an inch. The burner is used with fuel gas, or ordinary illuminating gas rendered non-luminous. It is mounted upon a suitable attachment for effecting the proper mixture of gas and air. The burner is intended principally for domestic service.

Mr. Lungren's paper was referred for publication.

Mr. F. Lynwood Garrison followed with some remarks on the progress of the manufacture of tin plate in the United States.

Mr. Swan, of London, England, exhibited a number of specimens of photogravures, made by an improved process of his devising, and gave a brief account of the history of the art leading up to his improvements. The specimens attracted much attention and comment, as being of unusual merit.

The Secretary, in his report, commented unfavorably upon the claims made in behalf of the experiments at present being made under the direction of the Department of Agriculture, for the artificial production of rain by means of explosions of considerable masses of dynamite, etc., in mid-air.

Mr. W. N. Jennings continued the exhibition of his series of local pictures.

Adjourned. WM. H. WAHL, *Secretary.*

JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA.

FOR THE PROMOTION OF THE MECHANIC ARTS.

VOL. CXXXII. DECEMBER, 1891. No. 6

THE Franklin Institute is not responsible for the statements and opinions advanced by contributors to the *Journal.*

THE HOLMES LUBRICANT BEARING.

[*Report of the Committee on Science and the Arts.*]

[No. 1646.] HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, August 28, 1891.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, to whom was referred, for examination,

PHILIP H. HOLMES' IMPROVED COMPOSITION FOR JOURNAL BEARINGS,

report that this invention aims to furnish a new composition of materials to be used in machinery as journal bearings, packings for sliding surfaces, etc., which possesses the requisite hardness to withstand the usual pressures, and also to offer a surface that, without the aid of oil or other lubricants, will reduce friction to a minimum and preclude the possibility of excessive or dangerous heating.